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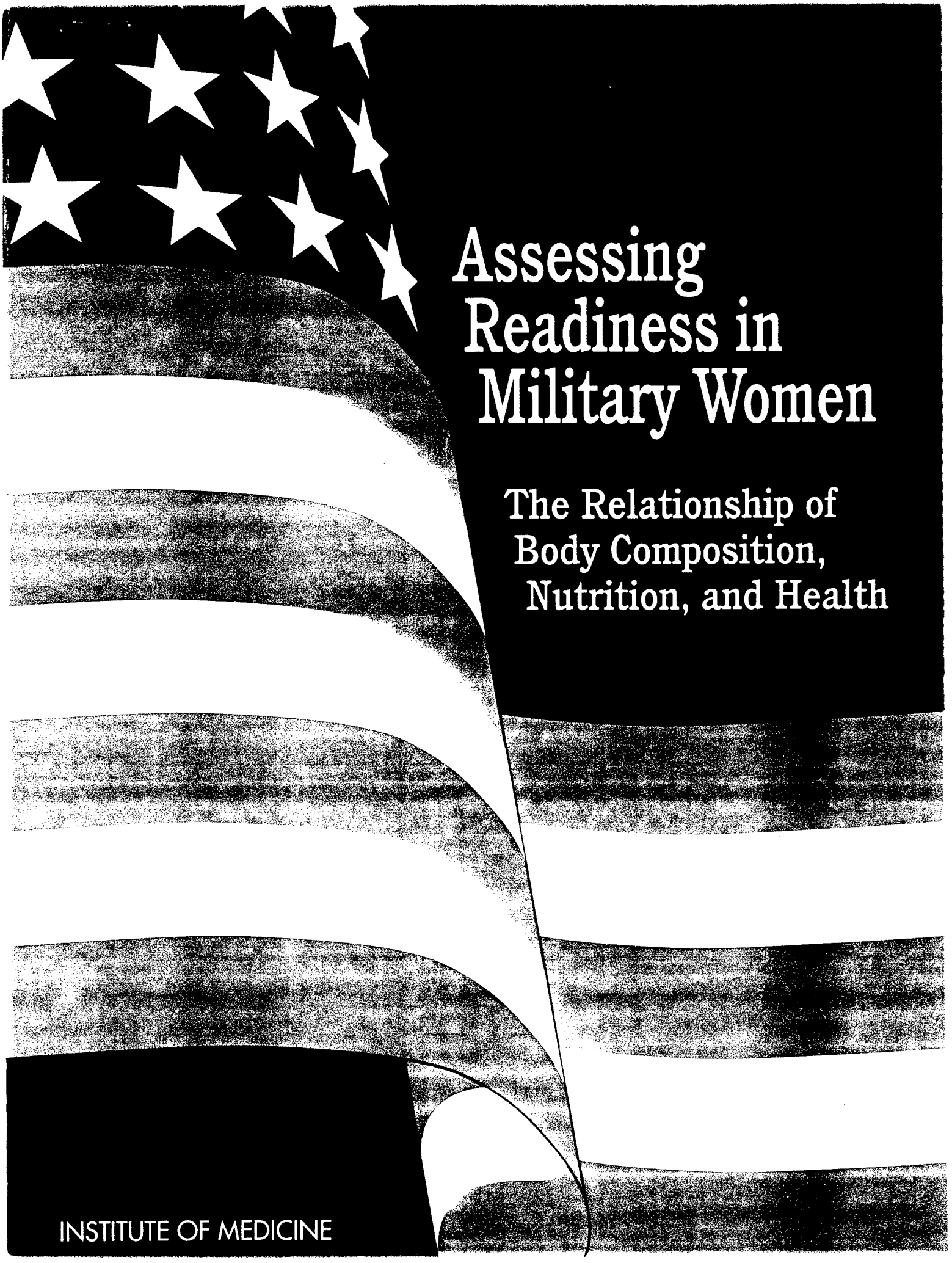
Approximately 200,000 women currently serve on active duty in the U.S. Armed forces (with an additional 150,000 serving in the Reserves), representing approximately 15 percent of all active-duty personnel. As a result of the downsizing of the military, the opening of more positions to women, and the inceasing frequency of sudden deployment, more women in the military must be "ready," that is, prepared to perform a variety of tasks under conditions that can be extremely adverse. Military readiness encompasses optimum health, fitness, and perofmrance. As part of the Defense Women's Health Research Program, a new report from the Committee on Body Composition, Nutrition, and Health of Military Women of the Institute of the Institute of Medicine examines issues of body ocmposition, fitness, and appearance standards and their impact on the health, nutritional status, and performance of active-duty women.

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Assessing Readiness in Military Women

The Relationship of Body Composition, Nutrition, and Health

INSTITUTE OF MEDICINE

A Report from the Institute of Medicine **March 1998**

ASSESSING READINESS IN MILITARY WOMEN

THE RELATIONSHIP TO BODY COMPOSITION, NUTRITION, AND HEALTH

Approximately 200,000 women currently serve on active duty in the U.S. Armed Forces (with an additional 150,000 serving in the Reserves), representing approximately 15 percent of all active-duty personnel. As a result of the downsizing of the military, the opening of more positions to women, and the increasing frequency of sudden deployment, more women in the military must be "ready," that is, prepared to perform a variety of tasks under conditions that can be extremely adverse. Military readiness encompasses optimum health, fitness, and performance. As part of the Defense Women's Health Research Program, a new report from the Committee on Body Composition, Nutrition, and Health of Military Women of the Institute of Medicine examines issues of body composition, fitness, and appearance standards and their impact on the health, nutritional status, and performance of active-duty women.

QUESTIONS ADDRESSED IN THE REPORT

- What body composition standards best serve military women's health and fitness, with respect to minimum lean body mass, maximum body fat, and site specificity of fat deposition? Are the appearance goals of the military in conflict with military readiness?
- Should any part of the Military Recommended Dietary Allowances (MRDAs) be further adjusted for women? Should there be any intervention for active-duty women with respect to food provided, dietary supplementation, or education?
- What special guidance should be offered with respect to return-to-duty standards and nutrition for women who are pregnant or breastfeeding?

KEY RECOMMENDATIONS

- Incorporate the use of body mass index (BMI) and fitness assessment into the current two-tier body composition assessment procedures used to determine compliance with body composition standards (first tier, weight-for-height; second tier, body fat assessment).
- Set the maximum allowable BMI at 25, based on considerations of health and chronic disease risk, with a maximum body fat of 36 percent if fitness test is passed.
- Increase emphasis on fitness for readiness in military personnel.
- Develop and validate a single, service-wide, circumferential equation for the assessment of women's body fat.
- Develop task-specific, gender-neutral strength and endurance tests and standards for use in the determination of placement in military occupational specialties that require moderate and heavy lifting.
- Reinforce efforts to provide complete nutritional labeling of all operational ration components and to design ration components that concentrate the nutrients that may be limiting in women's diets.
- Encourage military women to achieve and maintain healthy weights through a continuous exercise and fitness program, and provide nutrition education and ongoing counseling if weight loss is a goal.
- Encourage women to engage in a moderate exercise program during pregnancy when medically feasible.
- Set the time allowance for postpartum fitness testing at 180 days, and extend exemption from deployment to 6 months.
- Endorse the 1990 Institute of Medicine guidelines for gestational weight gain, and extend the time allowance for attainment of body weight standards to 1 year when satisfactory progress is being made.
- Redesign surveys to link demographic and personnel information to medical and health information.

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The serpent has been a symbol of long life, healing, and knowledge among almost all cultures and religions since the beginning of recorded history. The image adopted as a logotype by the Institute of Medicine is based on a relief carving from ancient Greece, now held by the Staatliche Museen in Berlin.



Assessing Readiness in Military Women

The Relationship of Body Composition, Nutrition, and Health

Committee on Body Composition, Nutrition, and Health of
Military Women

Committee on Military Nutrition Research

Food and Nutrition Board

INSTITUTE OF MEDICINE



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Preface

U.S. military personnel are required to adhere to standards of body composition, fitness, and appearance for the purpose of achieving and maintaining readiness. Military readiness, while encompassing many factors, can be defined briefly as maintenance of optimum health and performance so that deployment can occur at any moment.

In 1992, the Committee on Military Nutrition Research (CMNR) was asked to review existing policies pertaining to the body composition, fitness and appearance standards imposed for recruitment and retention in the armed forces to consider whether these standards are mutually supportive and whether they collectively support the health and performance of military personnel, or whether the standards actually oppose each other and negatively affect health and performance (IOM, 1992). Among the report's conclusions were that the standards of body composition required for women to achieve an appearance goal seemed to conflict with those necessary for performance of many types of military tasks. The committee recommended that body composition standards be based on considerations of task performance and health and be validated with regard to the ethnic diversity of the military. In addition, they recommended that task-specific performance tests be developed and that the wide disparity between recruitment and retention body composition standards for women be adjusted (to reflect those for men, thus rejecting fewer women at recruitment); the latter change was enacted by the Army prior to release of the report.

In 1994, as part of the Defense Women's Health Research Program, the CMNR was asked again to review existing military policies governing body composition and fitness, as well as postpartum return-to-duty standards, Military Recommended Dietary Allowances, and physical activity and nutritional practices of military women to determine their individual and collective impact on the health, fitness, and readiness of active-duty women. In particular, the committee was asked to evaluate whether existing body composition and appearance standards for women were in conflict with body composition requirements for task performance, and whether these same standards might interfere with readiness by encouraging chronic dieting and inadequate nutrient intake. In addition, the committee was asked to examine such policies and practices in comparable civilian services and to make recommendations regarding the body composition, physical performance, and postpartum return-to-duty standards that would best optimize the nutritional status, fitness, and health of active-duty women.

A subcommittee of the CMNR was established to review these topics. In addition to several members of the parent committee, individuals were included who have expertise in body composition assessment, physical fitness and performance, pregnancy and lactation, women's nutrition, weight management, epidemiology and survey design, and cognitive performance. This subcommittee was designated the Committee on Body Composition, Nutrition, and Health of Military Women (BCNH committee). In addition, a group of individuals representing the body composition, fitness, and nutrition research and policy making bodies of the Army, Navy, and Air Force were invited by the sponsor to form a liaison panel to advise the BCNH committee.

A small preliminary meeting was held in November 1995, including staff, the two committee chairs, and the sponsor's staff officer (LTC Karl E. Friedl). In April 1996, the full committee met with the liaison panel to define more clearly the focus of the task. A workshop was held in September 1996 to help gather information and impressions from other military representatives as well as several civilian researchers working in areas believed to be critical to the questions posed by the sponsor. Participants in the workshop were identified by committee and staff. A workshop summary was drafted and finalized at a meeting in January 1997, and based on the questions originally posed and those that were raised by the workshop, a comprehensive literature search was conducted by the staff and National Academy of Sciences librarians. The results of this literature search, as well as the expertise of the committee, the information gathered by staff attendance at conferences and discussion with representatives of civilian police and firefighting services (and with representatives of the Marine Corps and Coast Guard and other Army, Navy, and Air Force personnel) form the basis of this report, drafted at a meeting in June 1997 and served to help the committee to answer the sponsor's questions and formulate a set of recommendations.

Chapter 1 of the report provides a brief discussion of the methods used by the subcommittee to formulate recommendations in response to the questions posed by the military, as well as a demographic profile of active-duty women. Chapter 2 presents a discussion of the military body composition standards in light of what is known about the associations among body composition and health, fitness and performance, and appearance. Currently used methods of assessment, which form an integral aspect of the policy, are discussed along with research on newer techniques. Chapter 3 discusses the military fitness standards, their adequacy to ensure maintenance of fitness and avoidance of injury, the association between fitness and physical task

performance, recent efforts by the military to ensure that personnel can perform tasks requiring physical strength, and task performance tests used by civilian services. Chapter 4 discusses the military weight management programs, weight management methods used by military personnel and comparable civilian populations, and some of the risks of chronic dieting behavior. Chapter 5 further elucidates dieting risks from a nutritional standpoint and assesses the contribution of military operational rations and dining hall meals to the nutritional status of active-duty women. Chapter 6 discusses military pregnancy policies and their implications for health and fitness, and Chapter 7 provides the subcommittee's conclusions, recommendations, and suggestions for future research.

The committee wishes to acknowledge the help of Institute of Medicine president Kenneth I. Shine, Food and Nutrition Board division director Allison A. Yates and former acting director Carol Suitor, and the staff of the BCNH committee: former study director Bernadette M. Marriott, current study director Rebecca B. Costello; staff officer Sydne J. Carlson-Newberry; research assistants Susan M. Knasiak-Raley and Sheila A. Moats, former senior project assistant Donna F. Allen, project assistant Melissa L. Van Doren, Reports and Information Office director Michael A. Edington and associate Claudia M. Carl, National Academy of Sciences librarians Susan Fourt and Julie Walko. Additionally, the committee would like to thank editor Judith Grumstrup-Scott, members of the military liaison panel, and the individuals and organizations who provided information and materials.

This report has been reviewed by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the authors and the Institute of Medicine in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The content of the review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. The BCNH committee wishes to thank the following individuals for their participation in the review of this report: Elsworth R. Buskirk, Gilbert Burnett Forbes, Robert L. Goldenberg, Helen Lane, Sally A. Lederman, Roseann M. Lyle, David D. Schnakenberg, Marta Van Loan, and Richard J. Wood. While the individuals listed above have provided many constructive comments and suggestions, responsibility for the final content of this report rests solely with the authoring committee and the Institute of Medicine.

REFERENCE

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Assessing Readiness in Military Women

The Relationship of Body Composition, Nutrition, and Health

Executive Summary

Approximately 200,000 women currently serve on active duty in the U.S. Armed Forces (with an additional 150,000 serving in the Reserves), representing approximately 15 percent of the total active-duty personnel. The lifting of the combat exclusion rule in 1993 has resulted in the opening of large numbers of military positions that were previously closed to women and has increased the opportunities for women to advance in their careers. Thus, in spite of the current effort to decrease the size of the active-duty force, the percentage of women serving on active duty is increasing, as is the age and ethnic diversity of this population. As a result of the downsizing of the military, the opening of more positions to women, and the increasing frequency of sudden deployment, women in the military must be "ready," that is, prepared to perform a variety of tasks under conditions that can be extremely adverse. Military readiness encompasses optimum health, fitness, and performance. All military personnel are required to adhere to standards of body composition, physical fitness, and appearance[1] that are believed to promote readiness.

[1] The appearance standard is a policy enunciated by the Department of Defense (DoD) and shared among, but described slightly differently by, each branch of the Services. According to DoD Directive 1308.1 (1995), "Physical Fitness and Body Fat Programs," "maintaining desirable body composition is an integral part of physical fitness, general health, and military appearance" (p. 1). According to DoD Instruction 1308.3 (1995), the first line of body composition evaluation is by weight/height and appearance. Army Regulation 600-9 (1986) states, for example, that soldiers are to present a physical appearance in uniform "that is trim and

While the requirement that personnel adhere to such standards is mandated by the Department of Defense (DoDD 1308.1, 1981, 1995), each branch of service is permitted to set its own standards and to test compliance with these standards in a way that is compatible with the mission of that branch.

The use of body composition, physical fitness, and task performance standards to evaluate personnel, as well as the assessment methods used, are issues of utmost interest to the scientific community and constitute active areas of investigation. At the same time, many questions have been raised by military personnel, researchers, and advisory groups such as the Defense Advisory Committee on Women in the Services (DACOWITS) regarding the particular standards and assessment methods used by the Armed Forces, the differences among the branches of service, and the implications for personnel readiness. The purpose of this report, prepared under a grant from the Defense Women's Health Research Program, is to examine whether current standards for body composition, physical fitness, and appearance, and the methods used to assess compliance with those standards, support military readiness by ensuring optimal health and job performance of active-duty servicewomen.

THE COMMITTEE'S TASK

In 1992, the Committee on Military Nutrition Research (CMNR) of the Institute of Medicine (IOM) was asked by the U.S. Army to evaluate the body composition and fitness standards for personnel accession (recruitment) into and retention in all branches of active service, with regard to the impact of these standards on recruitment, physical fitness, and task performance in the Armed Forces. After conducting a workshop to investigate these issues, the CMNR released a report concluding that the standards of body composition that appeared to be required for women to achieve the desired appearance goal (low fat-free mass [FFM] and percent body fat) seemed to conflict with those necessary for performance of many types of military tasks (higher FFM often accompanied by increased body fat) (IOM, 1992). The committee recommended that body composition standards be based primarily on considerations of task performance and health and that they be validated with regard to the ethnic diversity of the military population. In addition, the committee recommended the development of task-specific performance tests; development of objective appearance standards, if these could be deemed necessary; and continuation of research on the relationships among body composition, health, and physical

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smart," one of the two goals of weight control. The regulation goes on to qualify the standard by emphasizing that enlarged waistlines, "potbellies," detract from good military appearance. No objective criteria (rating scales) have been associated with the appearance standard as it is enforced. (This is discussed further in Chapters 2 and 3). Only a small number of studies have examined how the appearance standard as enforced is linked to body composition. Although appearance is slightly associated with body fat, it is associated more significantly with abdominal circumference (AR 600-9, 1986; Hodgdon et al., 1990; Vogel and Friedl, 1992). Although Army, Navy, and Marine Corps personnel must supply recent photos of themselves to their selection (promotion) boards (this practice has been eliminated by the Air Force and de-emphasized by the Navy), appearance judgments can be rendered at any time. When these involve a suspicion of overweight (as opposed to untidy uniforms or other details of appearance), the individual must be weighed and may be required to have a body fat determination, and if necessary, to enter the weight management program (with attendant career consequences).

performance of military personnel. Also recommended was evaluation of the long-term outcome of individuals referred to military weight management programs for failure to adhere to standards.

At the autumn 1994 conference of DACOWITS, one of the concerns identified by the group was the need to address the body composition and physical fitness standards of the military and the impact of these standards on the health of women, particularly with regard to the potential influence of the standards on food intake and nutritional status. A report released by the IOM in 1995 to provide recommendations for research on the health of military women identified a number of gaps in research pertaining to the health and performance of military women. These included research on optimal physical fitness for military women, injury prevention, and ways to achieve and assess physical fitness, as well as fitness standards, including those for fitness during pregnancy and the postpartum period.

In 1995, in light of efforts to consider creation of DoD-wide fitness and body composition standards, calls to ensure that all personnel are physically able to perform their assigned tasks, and evidence suggesting that attempts to adhere to body composition and appearance standards may place active-duty women at special risk for inadequate nutrient intake, the CMNR was asked to appoint a subcommittee to examine issues of body composition, fitness, and appearance standards and their impact on the health, nutritional status, and performance of active-duty military women. Specifically, they were asked by the Army to address the following questions:

- What body composition standards best serve military women's health and fitness, with respect to minimum lean body mass, maximum body fat, and site specificity of fat deposition? Are the appearance goals of the military in conflict with military readiness?
- Should any part of the Military Recommended Dietary Allowances (MRDAs) be further adjusted for women? Should there be any intervention for active-duty women with respect to food provided, dietary supplementation, or education?
- What special guidance should be offered with respect to return-to-duty standards and nutrition for women who are pregnant or breastfeeding?

In April 1996, the CMNR convened a subcommittee comprising experts in the areas of body composition, exercise physiology, obesity, women's nutrition, epidemiology and survey design, cognitive psychology, and pregnancy and lactation. Several members of the parent committee were included to provide continuity. The subcommittee was designated the Committee on Body Composition, Nutrition, and Health of Military Women (BCNH committee).

METHODS

In considering the questions posed by the military, the subcommittee consulted with a liaison panel composed of military researchers and health care personnel. A workshop was convened in September 1996 to bring together additional military personnel in the areas of physical fitness assessment, training, medicine, and nutrition, as well as civilian researchers and practitioners in the areas of physical fitness and performance, pregnancy, eating disorder assessment, and

nutrition. The proceedings of this workshop, summarized in Appendix A, helped to focus the questions and identify sources of information. A search of civilian and military literature citation indices was conducted for the years 1991 to 1996, inclusive, to capture all military and civilian research that was relevant to the main issues and not captured by earlier IOM reports. Additional information was provided by those reports (IOM 1992, 1995), by searches of the General Accounting Office database and the World Wide Web, by the military liaison panel members, by individuals contacted at a number of military and civilian agencies, as well as by contacting representatives of municipal law enforcement and firefighting services nationwide. The BCNH committee drew upon these materials and its collective expertise to respond to the Army's questions and prepare their recommendations.

BACKGROUND

At the present time, the evaluation of body composition by each branch of the military is performed periodically by a two-step procedure (see Table S-1). The first step consists of a weight determination and comparison with a service-specific table of maximum allowable weights for height (along with an appearance determination). Personnel who exceed the weight-for-height limits for their gender (in the case of the Army and Air Force, also for age group) or who are judged to present a nonmilitary appearance are subjected to further assessment. This second step consists of body fat estimation using service-specific, circumference-based equations (Table S-2) standardized by underwater weighing. Each branch of service utilizes a different set of weight-for-height standards, body fat standards, and anthropometric equations. As a result, personnel who exceed the body fat standards for one branch of service may be in compliance with the standards of another branch. Personnel who fail to comply with the body fat standards of their own branch are referred to a weight management program (at the discretion of the commander). While administration of military weight management programs is left to each service individually, these programs generally require a single visit to a health professional, followed by regular weigh-ins until the weight and body fat goals are reached. Individuals are required to demonstrate continuing progress toward these goals by losing a prescribed number of pounds per month. Failure to show continued progress in weight loss, or continued failure to comply with body fat standards without a medical waiver, can result in separation from service.

Fitness is assessed by the military at the same time that body composition is determined. Each branch of service uses different test procedures (Table S-1). While aerobic fitness (endurance) is assessed by each service, the Army, Navy, and Marine Corps fitness tests incorporate additional tests of basic strength and flexibility (such as timed push-ups and sit-ups). Fitness test performance is rated on a gender- and age-specific scale. Unacceptable performance on the fitness test results in referral to a remedial program. Regular fitness training is mandated by the DoD, although duty time is not allowed for such training except in the Army and Marine Corps.

Testing of strength and task performance (as one of the qualifications for placement in military operational specialties [MOSs]), such as that currently used by most municipal firefighting services and many law enforcement agencies, is limited to the Air Force at the present time and to a very small number of MOSs in other branches of service.

TABLE S-1 U.S. Military Practices and Policies Pertaining to Body Composition, Fitness, and Pregnancy

Practice or Policy	DoD Directive/ Instruction	Army	Navy	Air Force	Marine Corps	Coast Guard
Frequency of Weight/Height, BF, and Fitness Assessment	Formally evaluated and tested at least annually	Semiannual	Semiannual PRT optional for members > 50 years (NAVOP 064/90, 1990)	Annual	Semiannual	At least annual and upon random urinalysis testing
Assessment Procedures*	Circumference measure technique	Circumference measure if maximum allowable weight for height exceeded	Circumference measure if maximum allowable weight for height exceeded	Circumference measure if maximum allowable weight for height exceeded	Circumference measure if maximum allowable weight for height exceeded	Frame size determined by wrist measure (see COMDTINST M1020.8C, 1994) Circumference measure if maximum allowable weight for height exceeded
Men's BF Standard	Range: 18–26%	Age Max %BF 17–20 20 21–27 22 28–39 24 40+ 26 (AR 600-9, 1986)	22%	Age %BF ≤ 29 20 30+ 24	18%	Maximum allowable weight by frame size or if exceeded Age %BF < 30 23 31–39 25 40+ 27
Women's BF Standard	Range: 26–36%	Age Max %BF 17–20 30 21–27 32 28–39 34 40+ 36 (AR 600-9, 1986)	30% (NAVADMIN 071/93, 1993)	Age %BF ≤ 29 28 30+ 32	26%	Maximum allowable weight by frame size or if exceeded Age %BF < 30 33 31–39 35 40+ 37
Fitness Test	Annual Adjusted for age and gender	Adjusted for age and gender (AR 350-41, 1993)	Sit-reach Curl-ups × 2 min Push-ups × 2 min	Submaximal cycle ergometer test, percent of standard	Men: 3-mi run Curl-ups Push-ups	None

Continued

TABLE S-1 *Continued*

Practice or Policy	DoD Directive/ Instruction	Army	Navy	Air Force	Marine Corps	Coast Guard
Fitness Test *continued*	Cardiovascular and muscular endurance (DoDI 1308.3, 1995)	2-mi run Sit-ups × 2 min† Push-ups × 2 min	1.5-mi run/walk or 500-yd swim (age and gender adjusted) + BF standards (OPNAVINST 6110.1D, 1990)	based on $\dot{V}O_2$max, age and gender specific (AFI 40-501, 1996)	Pull-ups × 2 min Women: 1.5-mi run Curl-ups Push-ups Bent-arm hang × 2 min	
Duty Time for Physical Fitness	May authorize 1½ hrs 3×/wk	Authorize duty time	Commanding officer's discretion	Commanding officer's discretion	Part of weekly training day	Commanding officer's discretion
Pregnancy		•Exempt from body composition, fitness testing (AR 40-501, 1995) •Nondeployable •At 20 weeks, standing at parade rest/attention < 15 minutes •At 28 weeks, 40-h week/8-h day	•Exempt from body composition, fitness testing •20-wk Rule (no shipboard duty after 20th week of gestation) •6-h Rule (medical evacuation for ER must be within 6 hours) (OPNAVINST 6000.1A, 1989) •40-h work week •Standing at parade rest/attention no more than 20 min	•Exempt from body composition, fitness testing •Restrictions based on work environment •Pregnant members assigned to areas without obstetrical care will have assignment curtailed by 24th week (AFI 44-102, 1996)	•Full-duty status and deployable until medical officer certifies that full duty is medically inadvisable •May not participate in contingency operations or be deployed for operations aboard Navy vessels •Flight personnel are grounded unless cleared by medical waiver •Excused from duties (physical training or standing in formation) that in the opinion of the medical officer are hazardous to her health or to her unborn child	•Exempt from body composition testing •>28 weeks, 40-h work week; no overseas duty •Other duty restrictions based on work environment; no rescue swimmer duties •Not deployable during 20th week through 6 months postpartum •Time to medical evacuation for emergencies < 3 hours •No flight duties after 2nd trimester •Prenatal sick leave not to exceed 30 days

				•Remains available for worldwide assignment •Pregnant Marines stationed in Hawaii will not be detached after their 6th month; if overseas, they may be detached at their normal rotation tour date; if assigned to shipboard duty, the Marine will be reassigned at first opportunity and no later than the 20th week of pregnancy	
Postpartum	•Return to duty at 6 weeks •Exempt from weigh-in until 6 months •Physical training at own pace for 45 days •Exempt from fitness testing for 135 days (FM 21–20, 1992) •Deferment from deployment until 4 months postpartum	•Return to duty at 6 weeks •Exempt from weigh-in until 6 months •Exempt from fitness testing for 6 months •Deferment from deployment until 4 months postpartum •No policy regarding breastfeeding	•Return to duty at 6 weeks •Exempt from weigh-in until 6 months •Deferment from deployment until 4 months postpartum •Exempt from fitness testing for 6 months (AFI 40-502, 1994) •Commander may approve up to 18 months deferral	•Return to duty at 6 weeks (or as soon after delivery as medical officer certifies) •Exempt from weigh-in until 6 months •Exempt from fitness testing for 6 months •Deferment from deployment until 4 months postpartum •(MCO 5000.12D, 1995)	For nursing mothers, the 6-mo weight standards exemption following delivery will begin at the conclusion of the nursing period, but no later than 12 months postdelivery •Postdelivery maternity leave up to 6 weeks •Not deployable until 6 months postpartum

Continued

TABLE S-1 *Continued*

Practice or Policy	DoD Directive/ Instruction	Army	Navy	Air Force	Marine Corps	Coast Guard
Postpartum *continued*		•No policy regarding breastfeeding		•No policy regarding breastfeeding	•No policy regarding breastfeeding	•Exempt from weight standards for up to 6 months

NOTE: DoD, Department of Defense; BF, body fat; PRT, physical readiness test; NAVOP, Naval Operational Message; COMDTINST, Commandant Instruction; AR, Army Regulation; NAVADMIN, Naval Administrative Message; DoDI, Department of Defense Instruction; OPNAVINST, Naval Operations Instruction; $\dot{V}o_2max$, maximal oxygen consumption; AFI, Air Force Instruction; FM, Field Manual; MCO, Marine Corps Order.

* See Table S-2 for equations.
† Number of sit-ups performed in 2 minutes.

TABLE S-2 U.S. Military Body Composition Equations

Army (Vogel et al., 1988)

Men

Percent fat = $76.5 \times \text{Log}_{10}(\text{abdomen II}^{*} - \text{neck}) - 68.7 \times \text{Log}_{10}(\text{height}) + 46.9$

$R = 0.82$, SEE = 4.02

Women

Percent fat = $105.3 \times \text{Log}_{10}(\text{weight}) - 0.200 \times \text{wrist} - 0.533 \times \text{neck} - 1.574 \times \text{forearm} + 0.173 \times \text{hip} - 0.515 \times \text{height} - 35.6$

$R = 0.82$, See = 3.60

Navy (Hodgdon and Beckett, 1984a, b) and Air Force

Men

Density = $-0.191 \times \text{Log}_{10}(\text{abdomen II} - \text{neck}) + 0.155 \times \text{Log}_{10}(\text{height}) + 1.032$

Percent fat = $100 \times [(4.95/\text{density}) - 4.5]$

$R = 0.90$, SEE = 3.52

Women

Density = $-0.350 \times \text{Log}_{10}(\text{abdomen I}^{\dagger} + \text{hip} + \text{neck}) + 0.221 \times \text{Log}_{10}(\text{height}) + 1.296$

Percent fat = $100 \times [(4.95/\text{density}) - 4.5]$

$R = 0.85$, SEE = 3.72

Marine Corps (Wright et al., 1980, 1981)

Men

Percent fat = $0.740 \times \text{abdomen II} - 1.249 \times \text{neck} + 40.985$

$R = 0.81$, SEE = 3.67

Women

Percent fat = $1.051 \times \text{biceps} - 1.522 \times \text{forearm} - 0.879 \times \text{neck} + 0.326 \times \text{abdomen II} + 0.597 \times \text{thigh} + 0.707$

$R = 0.73$, SEE = 4.11

NOTE: Circumference measurements and height are in centimeters. SEE, standard error of the estimate.

* Abdomen II is the circumference, measured in transverse plane, at the level of the umbilicus.

† Abdomen I is the "natural waist" and is defined as the smallest circumference, measured in the transverse plane, obtained between the lower margin of the xiphoid process and the umbilicus.

SOURCE: Adapted from Hodgdon (1992).

Throughout the military, women who become pregnant while on active duty are exempt from compliance with body composition standards until 6 months postpartum. Compliance with fitness standards must be achieved by 135 days (Army) to 180 days (Navy and Air Force), although medical waivers are permitted. Active-duty women are permitted 6 weeks maternity (convalescent) leave and are deployable at 4 months unless a medical waiver is granted.

FINDINGS

Although the current weight-for-height tables used by each branch of the military are derived from actuarial tables of mortality and morbidity risk, other estimates of body composition, such as the body mass index (BMI, weight in kilograms divided by the square of height in meters), have been shown to predict health risk with greater validity and equal ease; the BMI shows good correlation with total body fat in women of military age. The preponderance of evidence suggests that a BMI range of 19 to 25 is associated with minimal risk of morbidity and mortality. Table S-3 shows the BMIs corresponding to current Army weight-for-height limits, and Table S-4 shows the weight ranges that would correspond to a BMI range of 19 to 25 for representative heights.

The equations used by the military to predict body fat have been validated only against the method of underwater weighing and on a population of individuals who no longer reflect the age, ethnic, or gender profile of the current population of military personnel. (Approximately 40% of active-duty military women are members of a minority group, although the percentages differ by branch of service. The majority of active-duty women are under the age of 26[2]; the percentage above age 40 is very small.) Because of the test population used, technical problems with the reference method, and proposed variations in body fat distribution among ethnic groups, it has been hypothesized that the equations may not be valid and may underpredict or overpredict body fat for some groups, particularly when applied to women. However, thus far, systematic ethnic variations in body fat distribution remain controversial, there has been no evidence that the military equations have systematically overpredicted body fat in any ethnic group, and there are no data on how body fat assessments provided by these equations compare with estimations provided by four-compartment methods of body fat determination for women in various ethnic groups. The equations tend to underpredict body fat at levels close to the upper limits and above.

Data obtained from the Army *Health Risk Appraisal* database for 1995 on approximately 17,000 female soldiers revealed a mean BMI of 22.7 ± 3.29 (SD), with 13.9 ± 0.1 percent at a BMI of 27.3 or greater (the *Healthy People 2000* [DHHS, 1991] definition of obesity). It was not possible to obtain a breakdown of the percentage of women at each BMI, nor were comparable data available from the other branches of service. Estimates of overweight personnel were obtained from a self-report survey (*Survey of Health-Related Behaviors among Military Personnel*, Bray et al., 1995). According to this survey, approximately 10 percent of active-duty women

[2] Fifty-five percent of enlisted women and 16 percent of commissioned officers are under 26 years of age; nearly 4 percent of enlisted women and 19 percent of officers are over age 40.

TABLE S-3 Current Maximum U.S. Army Weight-for-Height Limits for Women (Screening Table Weight) with Corresponding Body Mass Index (BMI)* by Age Group

		Ages 17–20			Ages 21–27			Ages 28–39			Ages 40+		
Height		Weight			Weight			Weight			Weight		
(in)	(m)	(lb)	(kg)	BMI	(lb)	(kg)	BMI	(lb)	(kg)	BMI	(lb)	(kg)	BMI
58	1.47	109	49	22.9	112	51	23.6	115	52	24.2	119	54	25.0
59	1.50	113	51	22.8	116	53	23.4	119	54	24.0	123	56	24.8
60	1.52	116	53	22.7	120	54	23.4	123	56	24.0	127	58	24.8
61	1.55	120	54	22.7	124	56	23.4	127	58	24.0	131	59	24.8
62	1.58	125	57	22.9	129	59	23.6	132	60	24.1	137	62	25.1
63	1.60	129	59	22.9	133	60	23.6	137	62	24.3	141	64	25.0
64	1.63	133	60	22.8	137	62	23.5	141	64	24.2	145	66	24.9
65	1.65	137	62	22.8	141	64	23.5	145	66	24.1	149	68	24.8
66	1.68	141	64	22.8	146	66	23.6	150	68	24.2	154	70	24.9
67	1.70	145	66	22.7	149	68	23.3	154	70	24.1	159	72	24.9
68	1.73	150	68	22.8	154	70	23.4	159	72	24.2	164	74	24.9
69	1.75	154	70	22.7	158	72	23.3	163	74	24.0	168	76	24.8
70	1.78	159	72	22.8	163	74	23.4	168	76	24.1	173	78	24.8
71	1.80	163	74	22.7	167	76	23.3	172	78	24.0	177	80	24.7
72	1.83	167	76	22.6	172	78	23.3	177	80	24.0	183	83	24.8
Mean±SEM				22.8 ± 0.1			23.4 ± 0.1			24.1 ± 0.1			24.9 ± 0.1

NOTE: The height will be measured in stocking feet (without shoes), standing on a flat surface with the chin parallel to the floor. The body should be straight but not rigid, similar to the position of attention. The measurement will be rounded to the nearest inch with the following guidelines: if the height fraction is less than ½ in, round down to the nearest whole number in inches; if the height fraction is ½ in or greater, round up to the next highest whole number in inches.

The weight should be measured and recorded to the nearest pound within the following guidelines: if the weight fraction is less than ½ lb, round down to the nearest pound; if the weight fraction is ½ lb or greater, round up to the next highest pound.

All measurements will be in a standard physical training uniform (gym shorts and T-shirt, without shoes).

If the circumstances preclude weighing soldiers during the physical fitness test (PFT), they should be weighed within 30 days of the PFT.

* Weight in kilograms divided by the square of the height in meters.

SOURCE: Adapted from Army Regulation 600-9 (1986).

TABLE S-4 Expected Weight Ranges by Height for Women with Body Mass Index* Range of 19 to 25

Height		Weight Range	
(in)	(m)	(lb)	(kg)
58	1.47	90–119	41–54
59	1.50	95–125	43–57
60	1.52	97–127	44–58
61	1.55	101–133	46–60
62	1.58	104–137	47–62
63	1.60	108–142	49–64
64	1.63	111–146	50–66
65	1.64	115–151	52–69
66	1.68	119–157	54–71
67	1.70	122–161	55–73
68	1.73	125–164	57–74
69	1.75	129–170	59–77
70	1.78	134–176	61–80
71	1.80	137–180	62–82
72	1.83	140–184	64–84

* Weight in kilograms divided by the square of the height in meters.

under age 20 and over age 25 were overweight by the standards of *Healthy People 2000* (DHHS, 1991), while 6 percent of women aged 20 to 25 were overweight. However, these figures underestimate the percentages of women who are out of compliance with military weight standards. According to the same survey (Personal communication, R. M. Bray, Research Triangle Park, N.C., 1996), the prevalence of underweight (defined by the survey as a BMI < 19.8) is 14.5 percent for women under age 20, 11 percent for women ages 20 to 25, 10 percent for women ages 26 to 34, and 5 percent for women age 35 and older. The prevalence of BMI less than 19 ranges from 3.6 percent for all Navy women to 6.8 percent for Marine Corps women. Data on numbers of individuals separated from service for failure to comply with the weight standards were obtained (from Defense Manpower Data Center, Rosslyn, Va.) but do not provide an accurate picture of the percentage of personnel out of compliance because administrative separation is an action that is at the discretion of the commander.

Studies have shown that a significant percentage of female Army personnel, particularly those in the youngest age groups, fail the Army physical fitness test (for example, the failure rate of women in the 18–21 age group is 36%). Comparable data were not available for the other

branches of the military. Self report data show that approximately 60 percent of active-duty women exercise regularly. Anecdotal evidence shows that compliance with provision of duty time for fitness training is command dependent.

The performance of personnel on military fitness tests does not correlate well with their performance on task-specific performance tests or tests of the strength required for MOSs that demand heavy and moderately heavy lifting and carrying capabilities. Military researchers have recommended the adoption of task-specific performance tests, such as those used in the civilian sector; general and task-specific strength training; and where possible, task redesign.

Performance by military women on strength tests is correlated with higher body weight and associated FFM.[3] Because of higher FFM, women who exceed the weight-for-height standard during basic combat training may perform better on tests of strength than their thinner counterparts; however, women who exceed weight-for-height standards achieve slower run times (a measure of endurance capacity) than women who are in compliance with the weight standards. The maintenance of an appearance standard that promotes lower weight for height thus presents a dilemma for promotion of optimum physical readiness, especially for the more physically demanding (strength-requiring) MOSs.

It was not possible to obtain outcome data on any of the military weight management programs or information on how a representative sample of military sites administers their programs. Comparison of the programs as described in the regulations with current recommendations for civilian weight loss and management programs suggests that greater contact with nutrition professionals and nutrition education, increased emphasis on incorporating fitness and other lifestyle changes, and establishment of long-term maintenance programs may be necessary to ensure success of the programs.

Assessments of the nutritional status and food intake of active-duty women have been limited to small studies of women in temporary training and field settings. Results of these studies suggest that because the nutrient density of operational (field) rations and military dining hall menus is based on an average daily energy intake of 3,600 kcal, reliance on operational rations or dining hall offerings may make it difficult for women to obtain the recommended levels of calcium, iron, and folic acid while balancing energy intake with expenditure; moreover, the MRDAs have not been modified since 1985 and are based on the 1980 Recommended Dietary Allowances (RDAs). A large-scale nutritional survey of active-duty women in garrison and deployed throughout the world has recently been completed, and a study of energy expenditure in active-duty women is in progress.

Evidence also suggests that chronic dieting or frequent crash dieting to comply with weight standards may compromise women's nutritional status and fitness level. It is difficult at this time to ascertain the prevalence of disordered eating (as characterized by behaviors ranging from repeated crash dieting and/or chronic restrained eating to chronic starvation and/or cycles of bingeing and purging) among active-duty women. Survey data suggest that the percentage of active-duty women who perceive themselves to be overweight is high and exceeds the percent who actually are overweight. Evidence suggests that self-perception of overweight is linked to chronic dieting. Several small surveys have attempted to assess the percentage of active-duty personnel

[3] In reality, the skeletal muscle component of FFM.

who are engaging in disordered eating behaviors or other unhealthy weight management behaviors (such as use of diet pills and laxatives, purging, and excessive physical activity), and have reported incidences both similar to and significantly higher than those among comparable civilian populations. However these results must be called into question because of small sample sizes and low response rates, possibly reflective of the fact that until recently, diagnosis of an eating disorder has been considered grounds for discharge from the military, and the perception that this policy is still enforced has not disappeared.

Whether the incidence of disordered eating among active-duty women is comparable to or greater than among civilian women may be less important an issue, however, than the impact that chronic dieting and other disordered eating behaviors have been shown to have on operational performance. Research has demonstrated that chronic dieting by energy restriction results in significant decrements in performance on several tests of cognitive function; other studies have suggested that dieting increases the risk for amenorrhea and stress fracture injuries.

While a minority of active-duty women under the age of 26 are married (35% of enlisted and 30% of commissioned officers), the majority over the age of 26 are married (61% of enlisted and 60% of commissioned officers). The percentage of women who are parents varies considerably by service and status, ranging from 16 percent of Marine Corps officers to 42 percent of Army enlisted personnel. Very few data are available on pregnancy weight gain, nutrition, and exercise; postpartum weight loss; pregnancy outcome; and lactation among active-duty military women. Available data from civilian women suggest that it would be difficult for a woman whose gestational weight gain was within the range recommended by the IOM (1990) to return to her postpartum weight within the 6 months currently allowed. The body composition equations currently in use have not been validated on a postpartum population of women. No data were available regarding postpartum return to fitness for a military population.

RECOMMENDATIONS

The major recommendations are presented below in response to the questions posed by the Army.

What body composition standards best serve military women's health and fitness, with respect to minimum lean body mass, maximum body fat, and site specificity of fat deposition? Are the appearance goals of the military in conflict with military readiness?

- The BCNH committee recommends the revision of the two-tiered body composition and fitness screen.

As illustrated in Figure S-1, the first tier should consist of semiannual assessment of BMI and fitness (including strength and endurance). The acceptable range of BMIs, based on consid-

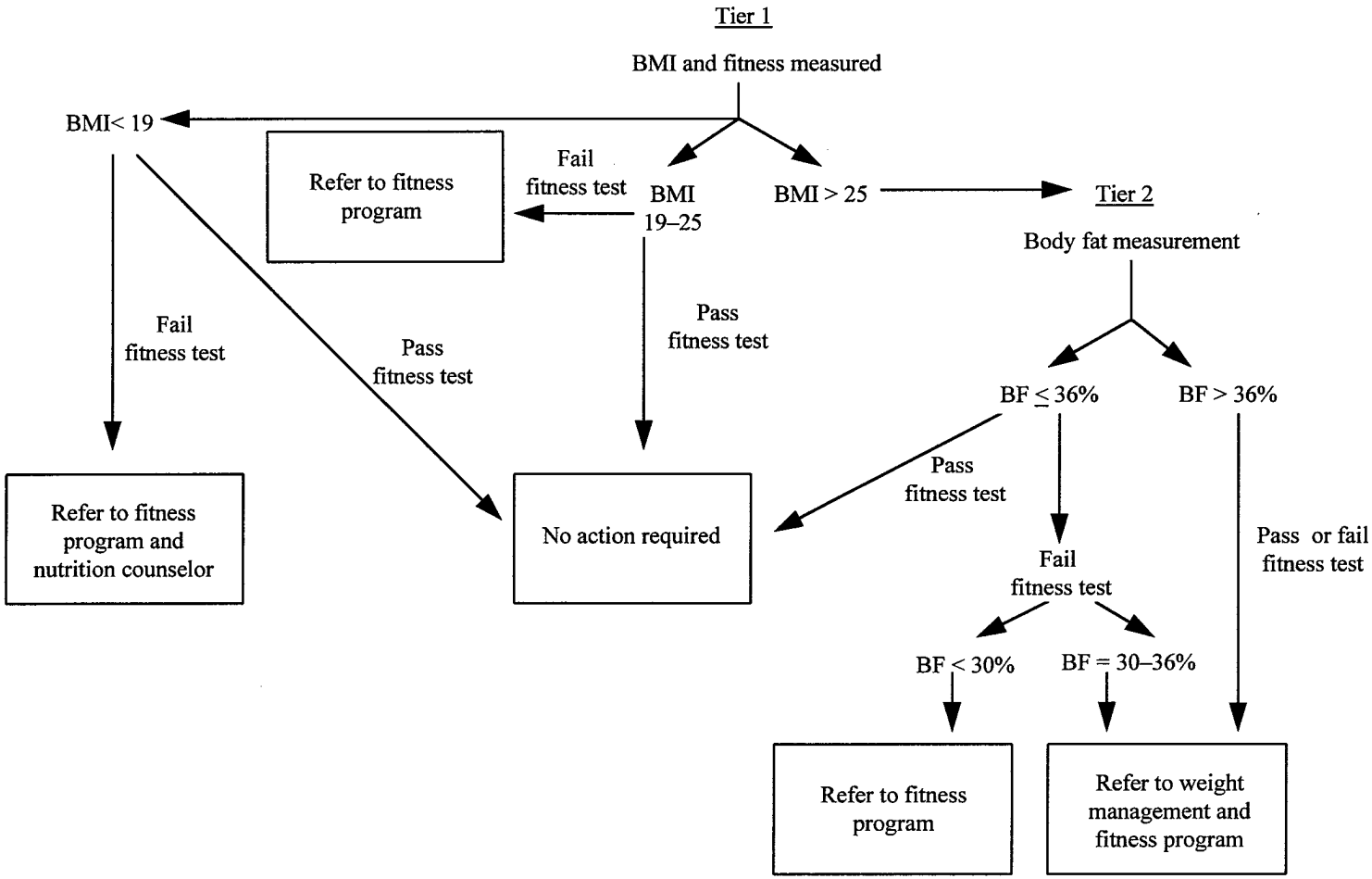


FIGURE S-1 Revised flow chart for screening recommendation. BMI, body mass index; BF, body fat.

erations of health, is recommended to be 19 to 25,[4] independent of age. Individuals whose BMI falls within the desirable range and who pass the fitness test need no further screening. Individuals with a BMI greater than 25 should be subjected to a second tier of screening, based on body fat assessment. The committee believes that women with BMIs less than 19 can be fit to perform. However, as BMI decreases below 19, women may be at risk for malnutrition and should be considered for medical evaluation.

Individuals whose body fat is assessed at 36 percent or less and who pass the fitness test will be considered within standard. Individuals whose body fat exceeds 30 percent and who fail the fitness test will be referred to weight management and fitness programs. Individuals whose body fat exceeds 36 percent will be referred to a weight management program, regardless of fitness score.

- The BCNH committee also recommends development of a single service-wide equation derived from circumference measurements for assessment of women's body fat, to be validated against a four-compartment model using a population of active-duty women or a population that is identical in ethnic and age diversity to that of military women. Development and validation of this equation may result in reconsideration of the recommended BMI cut-offs, in part as a result of establishing the measurement error.
- The BCNH committee recommends an increasing emphasis on general fitness for health and readiness by enforcing uniformly across all services and MOSs regular and monitored participation in a fitness program consisting of a minimum of 3 d/wk of endurance exercise at 60 to 80 percent of maximum capacity for 20 to 60 minutes and 2 d/wk of resistance exercise using all major muscle groups at 85 percent of one repetition maximum (ACSM, 1990). Such a program, in addition to promoting fitness, assists in maintenance of weight and FFM and may result in lower body fat. Periodic fitness and body composition testing adjusted appropriately for gender should be conducted to determine both endurance and strength and should be similar across all services. More frequent testing would promote continuous adherence to weight and physical fitness programs and decrease injurious behaviors that result from efforts to pass performance and body composition tests.
- The committee further recommends development of task-specific, gender-neutral strength and endurance tests and standards for use in the determination of placement in MOSs that require moderate and heavy lifting. Additional fitness programs should be created and enforced to develop and maintain the strength, endurance, and flexibility required by these MOSs.
- The BCNH committee recommends that, in view of the association between FFM (as an indirect indicator of skeletal muscle mass) and strength, the military consider developing an appropriate minimum recommended BMI for accession of women.
- The current appearance standard does not appear to be linked to performance, fitness, nutrition, or health. The BCNH committee recommends that if the military deems appearance standards to be necessary, objective criteria (that do not discriminate on the basis of ethnicity) should be developed and utilized.

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[4] Table S-2 shows the BMIs corresponding to current Army weight limits for women. Table S-3 shows the weight ranges that correspond to the recommended BMI range of 19 to 25.

Should any part of the MRDAs be further adjusted for women? Should there be any intervention for active-duty women with respect to food provided, dietary supplementation, or education?

- In view of current ongoing efforts by the Food and Nutrition Board to revise the RDAs upon which the MRDAs (AR 40-25, 1985) are based, the BCNH committee advises that revision of the MRDAs be deferred to a later time and has chosen to concentrate on several nutritional issues of importance to active-duty women.
- The BCNH committee reinforces the requirement for adequate energy and nutrient intakes to reflect the needs of the body at a moderate activity level (2,000–2,800 kcal/d). To ensure adequate nutrient intakes, female personnel must be educated on how to meet both energy and nutrient needs whether they are deployed and subsisting on operational rations or whether they are in garrison. This education is required to enable women to choose foods of higher nutrient density and to maintain a fitness program that will allow greater energy intake. The committee reinforces the recent efforts of the Army to begin providing complete nutritional labeling of all ration components and to include information to enable identification of nutrient-dense components that would help women meet the MRDAs at their usual energy intake. The committee also supports efforts to create ration supplements that would satisfy requirements that may not be readily met through the usual intake of rations. The committee recommends nutritional labeling of all dining hall menu items and provision of food selection guidelines to women in garrison.
- The BCNH committee recommends that all military women maintain or achieve healthy weight through a continuous exercise and fitness program. If weight loss is a goal, nutrition education and ongoing counseling should be provided for guidance in achieving a healthy, but reduced energy, diet. Emphasis must be placed on preventing overweight and maintaining long-term weight management through lifestyle changes, rather than on crash dieting to lose weight for a scheduled weigh-in. Adequate energy intake should be encouraged to reduce risks of injury and amenorrhea.

What special guidance should be offered with respect to return-to-duty standards and nutrition for women who are pregnant or breastfeeding?

- The BCNH committee recommends that all women be encouraged to eat an adequate diet during pregnancy and lactation as recommended by the IOM (1990, 1991). The committee further recommends an intake of 400 μ/d dietary folate during childbearing years, 600 μg/d dietary folate during pregnancy and 500 μg/d during lactation as recommended by the IOM (1998). A daily supplement of 30 mg of ferrous iron (IOM, 1990) is recommended during the second and third trimesters of pregnancy. During pregnancy and lactation, women should abstain from smoking. Although alcohol should be avoided during pregnancy, a very moderate intake may be permitted during lactation (IOM, 1990).
- The BCNH committee recommends that pregnant women without obstetrical or medical complications engage in moderate levels of physical activity to maintain cardiovascular and muscular fitness throughout the pregnancy and the postpartum period. The American College of Obstetricians and Gynecologists (ACOG, 1994) has published guidelines that should be used to

advise pregnant active-duty women to modify their physical fitness program. Programs should be individualized and made available to healthy women who can and wish to exercise. These programs may also incorporate strength training, although the extent of the benefits of such training during pregnancy remains to be determined.

- The BCNH committee recommends the endorsement of the IOM guidelines for gestational weight gain as outlined in the text. Women should be encouraged to gain within the IOM recommendations during pregnancy and to lose weight postpartum through appropriate nutritional counseling and exercise programs. The BCNH committee recommends that the proposed time allowance for compliance to weight and body fat standards postpartum be consistent with IOM recommendations for gestational weight gain. When satisfactory progress is being made toward compliance, an allowance of up to 1 year postpartum should be given for attainment of body weight standards.
- Resumption of exercise postpartum will depend on the type of delivery and postpartum state of the woman and should be left to the discretion of the woman's obstetrician. Once clearance is given to resume exercise, a time allowance of 180 days should be sufficient for the woman to meet physical fitness standards.
- The *Healthy People 2000* (DHHS, 1991) goal for breastfeeding specifies that at least 75 percent of women should breastfeed their babies in the early postnatal period and 50 percent of women should continue to breastfeed until their babies are 5 to 6 months old. As the military has provided no indication as to why they should not strive to comply with this goal, the committee recommends that efforts be made to promote and support breastfeeding among all servicewomen, where appropriate. Promotion of breastfeeding can be incorporated into prenatal classes, family support classes, hospital policies, and training of health care providers.
- The BCNH committee calls attention to the persistent anemia and musculoskeletal and cardiovascular changes that may continue in some women postpartum. These changes may present potential health problems for the mother and compromise her fitness status. Women with low iron stores before pregnancy or excessive blood losses at delivery may require an extended period (5–10 months) to replete and normalize stores.
- An increase in the length of exemption from deployment from 4 to 6 months postpartum is recommended to support maternal postpartum recovery, breastfeeding, and enhanced infant health and development.
- The BCNH committee acknowledges that childbearing is compatible with a military career when planning and education on effective birth control and counseling on the importance of timing pregnancy in one's military career are provided to all servicemembers. The committee therefore recommends training and education for all supervisory personnel regarding pregnancy policy, as well as a prenatal counseling program for pregnant active-duty women. These policies should be implemented to reduce attrition and enhance military readiness.

RECOMMENDATIONS FOR FUTURE RESEARCH

Currently, there are no systematically collected data describing what military women do to meet weight and fitness standards (both before and after childbirth), how effective their behav-

iors are at maintaining weight and fitness standards, and the long-term health consequences of these behaviors. A DoD-wide evaluation system is recommended.

Survey Design and Administration

Relevant Data from Previous Surveys of Military Personnel and in Existing DoD Databases

Several research projects have been conducted by the services on the health-related behaviors of servicemembers. In addition to the wide variety of demographic and personnel data maintained in the Defense Manpower Data Center database, health outcome data are maintained in several medical cost accounting databases.

Effective Use of Existing Data

A combination of the survey instruments that have been used in the past would be suitable for collecting most of the information needed (including longitudinal data). The personnel and medical databases are capable of producing much of the remaining information needed. However, the committee finds that there are two problems with this method of data collection. First, some of the survey data were collected anonymously (with no identification numbers of any type), precluding any attempt to examine the data longitudinally or merge the databases with existing personnel and medical databases that contain the demographic and health outcome data needed for a comprehensive analysis of the data. Second, the personnel and medical databases were not designed to be linked to each other or to survey databases. Thus, although much potentially worthwhile information is collected, little meaningful analysis can be performed.

Recommendations for New Methods

The committee recommends that the military survey a representative sample of active-duty personnel individually and review the individuals' personnel and medical records during the course of the interview. This method would enable the investigator to obtain all the data needed in a single effort, ensure quality control of the data, build a database that would preserve the anonymity of the individual, and obviate the need to merge automated information systems with highly sensitive data. However, the need to create a system that will obtain information from several large and representative samples of the entire DoD over the course of several years may make this choice cost-prohibitive.

An alternative recommendation is to expand the triennial *Survey of Health-Related Behaviors among Military Personnel* to include the demographic, medical, nutrition, fitness, and pregnancy data needed. Changing the questionnaire to include social security number, as was done with the Navy's *Perceptions of Wellness and Readiness Assessment* survey and the Army's *Health Risk Appraisal* survey, would permit a longitudinal and potentially integrated database to be developed. The practice of using questions from federal surveys of health and fitness-related

behaviors in the general U.S. population should be continued so that comparisons between military and civilian populations can be made.

Additional Data Needed

As recommended by an earlier IOM report (1992), longitudinal studies of people admitted to military weight management or remedial fitness programs should be conducted to determine the outcome of these programs as recommended changes in program procedures are implemented.

Career, active-duty, military women constitute a unique population of individuals who are required to maintain their weight and body fat and fitness at prescribed levels. Longitudinal studies of health risk factors (cardiovascular, musculoskeletal, metabolic) and outcomes are recommended for these women.

The DoD is encouraged to monitor pregnancy outcome (birthweight, preterm delivery, low birth weight and small-for-date infants, and congenital anomalies) as well as pregnancy wastage (miscarriage) according to service, rank, and MOS to identify potential problems associated with certain military jobs, physical training, or hazardous environments. Longitudinal studies are recommended on body weight and fitness of women who have given birth. It is recommended that health surveys be expanded to collect information on the pregnancy history of active-duty women. Suggested questions are those used by Evans and Rosen (1996).

Additional Research Recommendations

- Additional research is needed to refine and standardize anthropometric equations for body fat prediction and to validate them against current four-compartment models. This research must include a population that is representative of active-duty military women in ethnic and age profile.
- In view of the relationship between skeletal muscle/FFM and strength, and recent developments in the ability to assess these parameters, research is recommended to develop an expedient method for the prediction of FFM using anthropometric measurements.
- The use of standard military equations in postpartum women for estimating body fat at return-to-duty testing has not been validated. Therefore, the BCNH committee recommends that validation studies be conducted in these women, controlling for ethnicity, age, and parity.
- Task assessment and redesign are recommended, where appropriate, to ensure gender-neutral accession and retention standards in individual MOSs.
- Further research is recommended on the incidence and risk factors for stress fracture and other musculoskeletal injuries in active-duty women.
- Additional research is needed on the effects of environmental stressors on the nutritional status and needs of active-duty women. It is recommended that the military coordinate its research efforts in this area with those of the civilian sector.

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Introduction

The lifting of the combat exclusion rule in 1993 resulted in the opening of large numbers of military occupational specialties previously closed to women. Consequently, the percentage of female active-duty personnel is steadily increasing. As a result of the downsizing of the military (drawdown), the opening of more positions to women, and the increasing frequency of sudden deployment, women in the military must be prepared to perform many types of tasks, both cognitive and physical, under conditions that may, at times, be extremely adverse. According to an Army operations manual, "U.S. Army forces must be prepared to fight and win on short notice anywhere in the world, from blistering deserts to frigid wastelands, in rain forests, tundra, mountains, jungles and swamps, urban sprawl and all types of terrain in between" (FM 100-5, 1993). They must, in short, display readiness. Readiness in military terms encompasses optimum health, fitness, and performance. Military personnel are required to adhere to standards of body composition, fitness, and appearance[1] for the purpose of achieving and maintaining readiness.

[1] The appearance standard is a policy enunciated by the Department of Defense (DoD) and shared among, but described slightly differently by, each branch of the Services. According to DoD Directive 1308.1 (1995), "Physical Fitness and Body Fat Programs," "maintaining desirable body composition is an integral part of physical fitness, general health, and military appearance" (p. 1). According to DoD Instruction 1308.3 (1995), the first line of body composition evaluation is by weight/height and appearance. Army Regulation 600-9 (1986) states, for example, that soldiers are to present a physical appearance in uniform "that is trim and

The purpose of this report, prepared under a grant from the Defense Women's Health Research Program, is to examine whether the present standards for body composition, fitness and appearance support readiness by ensuring optimal health and performance of active-duty women.

In 1992, the Committee for Military Nutrition Research (CMNR) of the Institute of Medicine (IOM) released a report concluding that the standards of body composition required for women to achieve an appearance goal seemed to conflict with those necessary to perform many types of military tasks (IOM, 1992). The committee recommended that body composition standards be based primarily on considerations of task performance and health and that they be validated with regard to the ethnic diversity of the military. In addition, the committee recommended that task-specific performance tests be developed; that appearance standards, if deemed necessary, be made objective; and that research be conducted on the relationships among body composition, health, and physical performance of military personnel, as well as on the long-term outcome of individuals referred to military weight management programs for failure to adhere to standards.

COMMITTEE CHARGE

With the current report, a subcommittee of the CMNR, the Committee on Body Composition, Nutrition, and Health of Military Women (BCNH committee), reexamined these issues, focusing specifically on active-duty women. In light of recent efforts to consider creation of Department of Defense (DoD)-wide fitness and body composition standards (Personal communication, LTC K. E. Friedl, U.S. Army Medical Research and Materiel Command, Fort Detrick, Frederick, Md., 1997), calls to ensure that personnel are physically able to perform the tasks to which they are assigned, and evidence suggesting that efforts to adhere to body composition and appearance standards may place active-duty women at special risk for inadequate nutrient intake, the subcommittee undertook to respond to the following questions posed by the Army:

- What body composition standards best serve military women's health and fitness with respect to minimum lean body mass, maximum body fat, and site specificity of fat deposition? Are the appearance goals of the military in conflict with military readiness?

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smart," one of the two goals of weight control. The regulation goes on to qualify the standard by emphasizing that enlarged waistlines, "potbellies," detract from good military appearance. No objective criteria (rating scales) have been associated with the appearance standard as it is enforced. (This is discussed further in Chapters 2 and 3). Only a small number of studies have examined how the appearance standard as enforced is linked to body composition. Although appearance is slightly associated with body fat, it is associated more significantly with abdominal circumference (AR 600-9, 1986; Hodgdon et al., 1990; Vogel and Friedl, 1992). Although Army, Navy, and Marine Corps personnel must supply recent photos of themselves to their selection (promotion) boards (this practice has been eliminated by the Air Force and de-emphasized by the Navy), appearance judgments can be rendered at any time. When these involve a suspicion of overweight (as opposed to untidy uniforms or other details of appearance), the individual must be weighed and may be required to have a body fat determination, and if necessary, to enter the weight management program (with attendant career consequences).

- Should any part of the Military Recommended Dietary Allowances be further adjusted for women? Should there be any intervention for active-duty women with respect to food provided, dietary supplementation, or education?
- What special guidance should be offered with respect to return-to-duty standards and nutrition for women who are pregnant or breastfeeding?

The current body composition and fitness standards of the four service branches (see Appendix B) were examined in light of research exploring the relationships among body composition, fitness, performance, and health. Body composition assessment methodologies used by the military were examined with regard to the demographics of active-duty women and recent advances in assessment technology. In response to one of the major recommendations of the earlier IOM report (1992), fitness and performance testing methods currently in use by municipal police and firefighting services, other government agencies, and the Canadian Forces were explored.

To investigate the implications of meeting the body composition and appearance standards for women, the military weight management programs and dieting practices were examined and compared with civilian programs and practices. The potential health risks of chronic dieting were discussed in light of the high level of performance expected of military personnel. In addition, the subcommittee examined the risk of nutrient inadequacy that may result from women's need to maintain weight while consuming military rations or dining hall meals, assessed the implications of the average military woman's activity level for acquisition of adequate nutrients, and noted areas where further research is needed.

Finally, the impact of current policies regarding the time allotted to women postpartum to comply with body composition standards and pass their fitness tests was discussed with respect to the effect of exercise during pregnancy on pregnancy weight gain and loss, pregnancy outcome, and lactation.

DEMOGRAPHIC DESCRIPTION OF ACTIVE-DUTY MILITARY WOMEN

As shown in Table 1-1, nearly 200,000 women serve on active duty in the Army, Navy, Marine Corps, and Air Force today, comprising 12 to 16 percent of the enlisted and officer personnel (data provided by personal communication with DoD contacts in the Defense Manpower Data Center, Rosslyn, Va.). Of the women serving on active duty, 83 percent are in the enlisted corps, 1 percent are warrant officers, and 16 percent are commissioned officers; this age distribution by rank is similar to that for male personnel. Approximately 36 percent of these women serve in the Army, 33 percent in the Air Force, 27 percent in the Navy, and 4 percent in the Marine Corps (Bray et al., 1995).

The age distribution of active-duty women is shown in Table 1-2. While the majority of enlisted women are under the age of 25, the majority of officers are over the age of 25. Because of the much greater representation of enlisted women in the services, however, the vast majority of active-duty women are 25 or younger.

TABLE 1-1 Number of Women Serving on Active Duty in the Department of Defense (DoD) as of September 30, 1996

Branch of Service	Enlisted	Warrant Officer	Commissioned Officer	DoD (total)
Army	58,069	661	9,865	68,595
Air Force	52,128	0*	12,047	64,175
Navy	43,240	121	7,748	51,109
Marine Corps	7,821	125	625	8,571
DoD (total)	161,258	907	30,285	192,450

NOTE: Enlisted, pay grades E1 to E9; warrant officer, pay grades W1 to W5; commissioned officer, pay grades O1 to O11.

* The Air Force does not have personnel classified as warrant officers.

SOURCE: Defense Manpower Data Center (Rosslyn, Va., 1996).

TABLE 1-2 Percentage of Women in the U.S. Armed Forces by Rank and Age as of September 30, 1996

Rank	Age (years)	Number	Percentage
Enlisted	Unknown	22	0.01
	17–25	87,859	54.48
	26–40	67,350	41.77
	41–65	6,027	3.74
	Total	161,258	100.0
Warrant officers*	Unknown	0	0
	17–25	21	2.32
	26–40	706	77.84
	41–65	180	19.85
	Total	907	100.0
Commissioned officers	Unknown	76	0.25
	17–25	4,843	15.99
	26–40	19,726	65.13
	41–54	5,640	18.62
	Total	30,285	100.0

* The Air Force does not have personnel classified as warrant officers.

SOURCE: Defense Manpower Data Center (Rosslyn, Va., 1996).

The educational achievement of active-duty men and women is shown in Tables 1-3A and 1-3B. All active-duty service personnel are expected to have a high school graduation certificate or its equivalent; commissioning requires additional educational achievement. The range of educational achievement for active-duty women is extremely wide. With the exception of Marine Corps officers, women's educational attainment is equal to or better than that of their male counterparts in all services and ranks.

Across the services, ethnic minorities represent approximately 40 percent of active-duty women (Table 1-4). More complete data on the ethnic distribution of active-duty women are presented in Table 2-2. Data on the marital status and parity of active-duty women are presented in Chapter 6.

TABLE 1-3A Educational Attainment of Active-Duty Men in the U.S. Military

Branch of Service	Rank	Unknown	No High School	High School Graduate	Some College	BA/BS+	Other
Army	Enlisted	11.2	0.2	78.7	6.3	3.5	0.0
	Officer	4.3	0.0	3.4	5.0	87.2	0.0
Air Force	Enlisted	0.6	0.0	18.1	76.2	4.9	0.2
	Officer	1.0	0.0	0.0	0.4	98.6	0.0
Marine Corps	Enlisted	0.0	0.1	94.6	1.4	1.2	2.6
	Officer	0.3	0.1	10.2	1.7	86.7	1.0
Navy	Enlisted	0.4	2.3	91.1	2.0	2.7	1.5
	Officer	8.8	0.0	5.1	1.8	84.2	0.0

TABLE 1-3B Educational Attainment of Active-Duty Women in the U.S. Military

Branch of Service	Rank	Unknown	No High School	High School Graduate	Some College	BA/BS+	Other
Army	Enlisted	14.8	0.2	70.7	9.0	5.3	0.0
	Officer	3.1	0.0	1.6	2.5	92.9	0.0
Air Force	Enlisted	0.7	0.0	26.1	67.9	5.1	0.1
	Officer	1.5	0.0	0.0	0.8	97.7	0.0
Marine Corps	Enlisted	0.3	0.0	91.9	2.9	2.7	2.2
	Officer	0.1	0.3	13.8	2.0	83.2	0.5
Navy	Enlisted	0.4	0.4	92.8	2.9	3.1	1.0
	Officer	9.0	0.0	2.8	1.8	86.4	0.0

NOTE: Highest level of education completed, expressed as percent of total number in rank and service, as of June 1997.

SOURCE: Defense Manpower Data Center (Rosslyn, Va., 1997).

TABLE 1-4 Percentages of Minority* Active-Duty Women in the U.S. Military by Service, Age, and Rank as of September 30, 1996

Service/Age (years)	Enlisted (%)	Warrant Officers† (%)	Commissioned Officers (%)
Army			
17–25	54	10	24
26–40	66	46	31
41–65	63	37	28
Navy			
17–25	45	0	22
26–40	44	27	20
41–65	33	16	14
Marine Corps			
17–25	40		14
26–40	49	34	15
41–65	45	24	9
Air Force			
17–25	31		18
26–40	36		18
41–65	40		19

* According to IOM (1995), approximately 75% of minority women in the military identify themselves as African American, 12.5% as Hispanic, 6.25% as Asian-American/Pacific Island, and 3.75% as Native American or other. These breakdowns were not available for individual branches of service.

† Warrant officers are a group of enlisted personnel who hold positions requiring highly specialized technical skills, but who are not commissioned officers. The Air Force does not have personnel classified as warrant officers. The Army, Navy, and Marine Corps are eliminating this category of jobs.

SOURCE: Defense Manpower Data Center (Rosslyn, Va., 1996).

METHODS AND RESOURCES USED FOR THE REPORT

To help gather information, the BCNH committee, in consultation with a liaison panel of military researchers and health care personnel, convened a workshop of additional military personnel and civilian researchers and practitioners in the areas of physical fitness and performance, nutrition, and pregnancy. The proceedings of this workshop, summarized in Appendix A, helped to focus the questions originally provided by the Army.

Drawing on the presentations at the workshop, background materials provided, and the expertise of the subcommittee, staff and National Academy of Sciences librarians searched the bibliographic databases Medline, Psychlit, Sport, National Technical Information Service (NTIS), and Defense Research On-line System (DROLS)/Defense Technical Information Center (DTIC) Work Unit and Technical Report (see Appendix D) for the years 1991–1996, inclusive. (The 1995 IOM report, *Recommendations for Research on the Health of Military Women*, and the 1992 IOM report, *Body Composition and Physical Performance*, which contained extensive bibliographies of earlier reference materials, were also used.) The goal of the searches was to capture both civilian and military research relevant to the main issues. The strategy used for the literature searches is described in Appendix D. Additional references and information were provided by searches of the General Accounting Office database and the World Wide Web, as well as by consultation with the military liaison panel; with individuals at the Pentagon, San Diego Naval Health Research Center, U.S. Army Research Laboratory, U.S. Army Center for Health Promotion and Preventive Medicine, U.S. Army Research Institute of Environmental Medicine, and U.S. Army Medical Research and Materiel Command; and with attendees at a symposium on Women in Uniform sponsored by the Women's Research and Education Institute. Finally, a sample of municipal firefighting and police services, as well as the U.S. Park Service and Forestry Service, Federal Bureau of Investigation, Drug Enforcement Agency, and the U.S. Marshals were contacted (see Appendix E) to obtain information on their body composition, fitness, and performance testing, as well as pregnancy policies.

The multiple strategies used to gather reference material provided the committee with a wide array of information upon which to draw in formulating its conclusions. In selecting research reports for review, every attempt was made to include only those that demonstrated use of the highest quality study design. However, because of the limited availability of published research in a number of areas, particularly research of relevance to the military, a decision was made to include all available reports in such areas and to discuss the limitations of the work, where appropriate.

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2

Body Composition

At the present time, all active-duty military personnel must be weighed and assessed for physical fitness annually or semiannually. If their weight exceeds the maximum for their height according to the screening tables of their service, they are referred for a second tier of assessment, determination of percent body fat, to ascertain that the increased weight is due to fat rather than lean tissue. Personnel whose body fat is found to exceed the limit for their service are referred to a military weight control program, which carries professional consequences. In addition to regular mandatory weighing, a commander may require an individual in his or her command to be weighed at any time if the commander believes that the individual presents an overweight appearance in uniform. Similar attention is not devoted to personnel who are underweight; however, this was not always the case.

HISTORICAL BACKGROUND

Beginning during World War II, the body composition of prospective soldiers was assessed to ensure that they possessed a minimum weight for their height and an appearance that was believed to be commensurate with fitness and health, in the judgment of a physician. However, in response to a growing impression throughout the late 1970s that the average servicemember appeared to be overweight and unfit, President Jimmy Carter commissioned a study in

1981 of the physical fitness of the military services (*Study of the Military Services Physical Fitness*, DoD, 1981). As a result of this study, the Department of Defense (DoD) issued Directive 1308.1 (1981) mandating that all services establish a system of body fat assessment to evaluate overweight. Weight-for-height tables such as the actuarial tables published by the Metropolitan Life Insurance Company, which established upper limits of weight for height that minimized risk of morbidity and mortality, were to be used as the initial screen. Assessment of body fat was to be performed on those who exceeded the maximum weight for their height. Fitness assessments were to be performed on all soldiers as well (see Chapter 3). Each service was given responsibility for establishing its own method of body fat assessment. The method generally chosen was that of skinfold thickness measurement and use of the Durnin-Womersley equation (1974) to predict percent body fat. The Marine Corps was the first service to validate and employ equations based on circumferential measurements for body fat assessment (Wright et al., 1980). In 1987, an amendment to the DoD Directive specified that a circumference-based body fat estimation procedure was to be used, standardized against the criterion method of hydrostatic (underwater) weighing. Subsequently, each of the other services derived its own gender-specific equations (Table 2-1), selecting by factor analysis the circumferential measurements and other factors that best predicted body fat as determined by underwater weighing of its own subject population (Hodgdon, 1992). Unlike those of the Army, Navy, and Marine Corps, the initial Air Force equation included an estimate of fat-free mass (FFM); however, this method was subsequently abandoned, and slight modifications of the Navy equations are now in use by the Air Force. The current standards are described in Table 2-2 and will be discussed in greater detail later.

According to DoD Directive 1308.1 (1981), which mandated body fat assessment, the maintenance of a desirable body composition was "an integral part of physical fitness, general health, and military appearance" (p. 1). The study panel that was given responsibility to set upper body fat limits for the DoD recommended upper limits of 20 percent body fat for men and 29 to 30 percent for women, based on information in the textbook of McArdle et al. (1981) showing that the average body fat of physically fit young men was 20 percent and that of fit young women was approximately 30 percent, corresponding to an average maximal aerobic capacity of 50 and 39 ml/kg/min for men and women, respectively (these body fat figures contained a margin of 5% to allow for deviation from the mean and measurement error). However, the DoD decreased the maximum allowable body fat for women from the recommended 29 to 30 percent to a figure of 26 percent, in the belief that it was desirable to recruit women whose body fat was closer to that of the average man, as such women, possessing a higher than average proportion of FFM, might also be more similar to men in strength and endurance. There has been considerable discussion regarding whether these original standards were based more on considerations or beliefs about fitness, health, or possibly appearance. According to Friedl (1997), the standards were intended to enhance readiness. However, except for the exclusion of extremely obese individuals, the standards could not select for fitness or performance capability; they were intended to promote fitness and prevent obesity.

A 1995 update to DoD Directive 1308.1 established new upper limits for body fat of 26 percent for men and 36 percent for women, however each service was permitted to set upper limits of less than 26 and 36 percent. Thus, for example, the Army maintains progressively increasing upper limits of body fat for increasing age (the upper body fat limit for women ranges

TABLE 2-1 U.S. Military Body Composition Equations

Army (Vogel et al., 1988)

Men

Percent fat = 76.5 × Log_{10}(abdomen II* – neck) – 68.7 × Log_{10}(height) + 46.9

R = 0.82, SEE = 4.02

Women

Percent fat = 105.3 × Log_{10}(weight) – 0.200 × wrist – 0.533 × neck – 1.574 × forearm + 0.173 × hip –0.515 × height – 35.6

R = 0.82, See = 3.60

Navy (Hodgdon and Beckett, 1984a, b) and Air Force

Men

Density = –0.191 × Log_{10}(abdomen II –neck) + 0.155 × Log_{10}(height) + 1.032

Percent fat = 100 × [(4.95/density) – 4.5]

R = 0.90, SEE = 3.52

Women

Density = –0.350 × Log_{10}(abdomen I† + hip + neck) + 0.221 × Log_{10}(height) + 1.296

Percent fat = 100 × [(4.95/density) – 4.5]

R = 0.85, SEE = 3.72

Marine Corps (Wright et al., 1980, 1981)

Men

Percent fat = 0.740 × abdomen II – 1.249 × neck + 40.985

R = 0.81, SEE = 3.67

Women

Percent fat = 1.051 × biceps – 1.522 × forearm – 0.879 × neck + 0.326 × abdomen II + 0.597 × thigh + 0.707

R = 0.73, SEE = 4.11

NOTE: Circumference measurements and height are in centimeters. SEE, standard error of the estimate.

* Abdomen II is the circumference, measured in transverse plane, at the level of the umbilicus.

† Abdomen I is the "natural waist" and is defined as the smallest circumference, measured in the transverse plane, obtained between the lower margin of the xiphoid process and the umbilicus.

SOURCE: Adapted from Hodgdon (1992).

TABLE 2-2 Variables or Standards Used by the U.S. Military Services for Assessing Body Composition of Personnel

Variables or Standards	DoD Directive/ Instruction	Army	Navy	Air Force	Marine Corps	Coast Guard
Frequency of Weight/Height, BF, and Fitness Assessment	Formally evaluated and tested at least annually	Semiannual	Semiannual PRT optional for members > 50 years (NAVOP 064/90, 1990)	Annual	Semiannual	At least annual and upon random urinalysis testing
Assessment Procedures*	Circumference measure technique	Circumference measure if maximum allowable weight for height exceeded	Circumference measure if maximum allowable weight for height exceeded	Circumference measure if maximum allowable weight for height exceeded	Circumference measure if maximum allowable weight for height exceeded	Frame size determined by wrist measure (see COMDTINST M1020.8C, 1994) Circumference measure if maximum allowable weight for height exceeded
Men's BF Standard	Range: 18–26%	Age / Max %BF 17–20 / 20 21–27 / 22 28–39 / 24 40+ / 26 (AR 600-9, 1986)	22%	Age / %BF ≤ 29 / 20 30+ / 24	18%	Maximum allowable weight by frame size or if exceeded Age / %BF < 30 / 23 31–39 / 25 40+ / 27
Women's BF Standard	Range: 26–36%	Age / Max %BF 17–20 / 30 21–27 / 32 28–39 / 34 40+: / 36 (AR 600-9, 1986)	30% (NAVADMIN 071/93, 1993)	Age / %BF ≤ 29 / 28 30+ / 32	26%	Maximum allowable weight by frame size or if exceeded Age / %BF < 30 / 33 31–39 / 35 40+ / 37

NOTE: DoD, Department of Defense; BF, body fat; PRT, physical readiness test; NAVOP, Naval Operational Message; COMDTINST, Commandant Instruction; AR, Army Regulation; NAVADMIN, Naval Administrative Message. A more detailed table appears in Appendix B.

* See Table 2-1 for equations.

from 30% for women 17–20 years of age to 36% for women 40 and older); the Navy maintains an upper body fat limit of 36 percent but requires women whose body fat exceeds 30 percent to enter a weight reduction program; and the Air Force maintains an upper body fat limit of 28 percent for women under 30 years and 32 percent for women 30 and over. The question of whether these body fat standards and the means used to assess them are truly related to health, fitness, or even appearance is still of prime significance, as is the question of whether one body fat standard and one method of assessment should be adopted by all services. These issues are particularly important for women in the military and have been the focus of at least one legal case (Adde, 1996).

Summary

Since 1981, the military has employed a two-tiered system of assessing body weight and fatness in its soldiers, as one means of ensuring readiness. All soldiers are weighed annually or semiannually; those whose weight exceeds the service-specific upper limit for their height must undergo circumferential body fat determination. Soldiers who exceed the body fat limits for their service and gender are referred to a military weight control program and suffer professional consequences. The methods by which body fat is assessed, the standards used, and the relationships among body fat, physical performance, health, and appearance of soldiers remain significant issues in the military today.

OVERVIEW OF BODY WEIGHT AND COMPOSITION

Body weight, after adjusting for stature, is related to an individual's health, functionality, and appearance. This section examines general body composition concepts. Subsequent sections provide an overview of measurement methods, and explore various influencing factors of importance to the military. The final portion of the chapter provides an overview of associations among body weight and composition, and health, functional issues of military significance, and appearance. Body weight *per se* is the sum of individual body composition components or compartments, which are of greater physiological or pathological significance than composite body mass.

General Concepts

Body weight or mass represents the sum of over 35 body composition components (Wang et al., 1992). Interpretation of body weight in relation to health issues requires adjustment for stature. Both relative underweight and overweight are accompanied by impaired physical performance and increased risk of morbidity and mortality. Setting weight standards for optimum health and physical performance is a subject of great scientific and public health importance and a current active research area.

A growing literature supports the use of body mass index (BMI, formerly referred to as Quetelet's index, defined as weight in kilograms divided by the square of height in meters), as a predictor of morbidity and mortality risk (Seidell et al., 1996; Troiano et al., 1996). BMI varies

from a low of about 14 kg/m^2 to over 100 kg/m^2, with "health" considered by most federal agencies as between approximately 18 kg/m^2 to 28 kg/m^2. Studies on the predictive value of BMI have included both cross-sectional observations and longitudinal prospective studies. BMI tabulations now supplant earlier mortality tables based on body weight and height such as those published by the Metropolitan Life Insurance Company (1983) for a first level of body fat assessment.

Body Mass Index

The association between morbidity/mortality and BMI varies among studies, but the consensus is that both low and high BMIs increase the risk of multiple degenerative conditions and diseases (Seidell et al., 1996; Troiano et al., 1996). The increased health risk of low BMI persists even after controlling for conditions associated with low relative weight such as malignancies and personal habits such as smoking. The 1995 *Nutrition and Your Health: Dietary Guidelines for Americans* suggested a range of BMI of 19 kg/m^2 to 25 kg/m^2 for healthy Americans (USDA/DHHS, 1995) with no age adjustment for this BMI range. The *Dietary Guidelines* now supplant the earlier National Research Council Recommended Healthy Weight Guideline (1989). The 1989 National Research Council Guideline was based on body weight and height with an adjustment of the healthy weight range for age. The lower weights more often applied to women, who tend to have less muscle and bone. The *Dietary Guidelines*' BMI range for health also suggests that higher weights may apply to people with more muscle and bone, such as many men.

The BMI range of 19 to 25, recommended by the *Dietary Guidelines* as being consistent with minimal risk, is supported by several recent studies. A longitudinal study of nurses (Manson et al., 1995) found a significant trend in the relationship between risk of death from all causes and increasing BMI relative to those with BMI less than 19 among women who had never smoked and whose weight had remained stable over the previous 4-y period; women in the BMI range of 19.0 to 26.9 were found to have similar risk (1.2–1.3) relative to women with BMI less than 19. Risk did not increase significantly until BMI reached 27. Kannel and coworkers (1996) reported that the BMI associated with lowest risk of cardiovascular disease for women is 21.1. Findings similar to those of Manson and coworkers (1995) were obtained in a more recent 12-y study of women who had never smoked (Stevens et al., 1998). While a BMI of 17 to 18.4 has been associated with chronic energy deficiency (James et al., 1988), data presented later in this chapter show that women with low BMI can be extremely physically fit.

The *Dietary Guidelines*' BMI range of 19 to 25 kg/m^2 is not supported by all investigators, however. In a recent meta-analysis, Troiano and colleagues (1996) demonstrated using available literature that weight levels now considered moderately overweight are not associated with significantly increased all-cause mortality. Moreover, body weight at or just below currently recommended limits was not associated with significantly increased mortality. Troiano and colleagues suggested that weight loss to increase longevity may be inappropriate for persons with BMIs in the range of 26 to 27 kg/m^2. (Discussions of health risks associated with dieting appear in later chapters.) In a 12-y longitudinal study, Seidell et al. (1996) also could not confirm a higher mortality risk in obese Dutch women compared to their lean counterparts. Van Itallie (1985) in a review recently cited by Rosenbaum and coworkers (1997) found that risk of nonin-

sulin dependent diabetes mellitus (NIDDM) and cardiovascular disease was increased three- to fourfold at a BMI greater than 28.

As an example of how current military weight-for-height table values correspond to BMI, the maximum allowable Army weights-for-height for women age 17 to 20 years correspond to a mean (± SEM) BMI of 22.8 ± 0.1; for women age 21 to 27 years, mean BMI is 23.4 ± 0.1; for women ages 28 to 39 years, mean BMI is 24.1 ± 0.1 and for women age 40 years and over, mean BMI is 24.9 ± 0.1.

However, as shown by Behnke and colleagues in the 1940s in a population of athletes and Navy personnel, increased weight for height may signify greater than average muscle mass rather than excess body fat in the individual (Welham and Behnke, 1942). Thus, a second level of body composition assessment must be applied to distinguish accurately between those who are overfat and those with greater than average muscle mass among those individuals whose BMI exceeds the designated maximum.

Components of Body Composition

The composition of the human body can be described on increasingly complex levels: atomic, molecular, cellular, anatomical, and whole body (see Figure 2-1) (Baumgartner et al., 1995; Wang et al., 1992). Readiness, fitness, and health in military women focus on two of these levels, molecular, and anatomical.

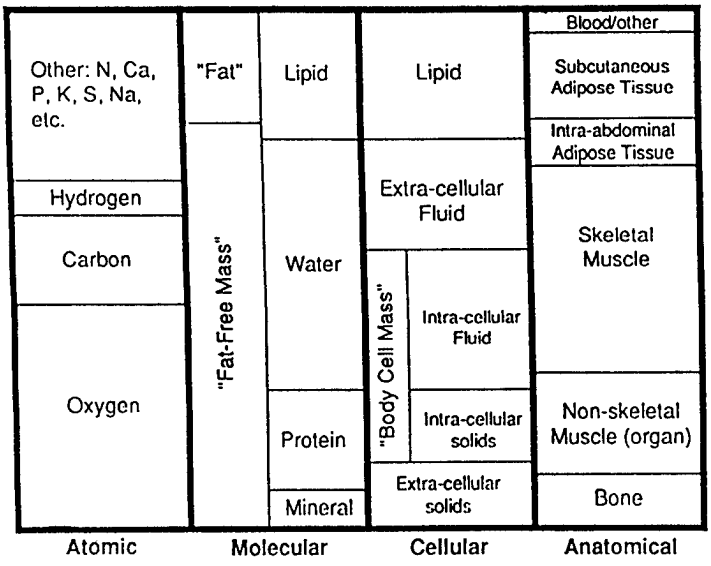


FIGURE 2-1 First four levels of body composition and their main components. SOURCE: Baumgartner et al. (1995). Permission for use granted by *Obesity Research.*

On the molecular level the body can be divided into four main components: lipid, water, protein, and minerals (Wang et al., 1992). In addition to fat, the remaining molecular components of the body, namely, water, proteins, and minerals, are found in relatively stable proportions to one another and are grouped under FFM (Wang et al., 1992).

At the anatomical level, the body includes adipose tissue, skeletal muscle, bone, visceral organs, and other related components (Wang et al., 1992). Adiposity and fatness are closely related, and the two, for military purposes, can be considered equivalent components. An individual's fat mass is related to overall energy balance, health, fitness, and appearance. Increases in fat mass and percent body fat are associated with greater morbidity and mortality due to such factors as lipid-mediated cardiovascular risk (Seidell et al., 1987). Increased fatness is associated with a decrease in some aspects of fitness, as will be discussed briefly in this chapter and in greater detail in Chapter 3. Percent body fat and fat distribution also contribute to the subjective assessment of appearance.

The difference between body weight and fat mass is FFM, a component associated with both strength and endurance. Under usual circumstances, skeletal muscle constitutes about one half of FFM (Wang et al., 1996). Hence, FFM and closely related adipose tissue-free mass are usually considered surrogate measures of skeletal muscle mass. For example Hodgdon and colleagues (1990) observed a positive association among Navy women between FFM (but not fat mass) and maximal box lifting capacity and other strength measures. Gender differences in strength disappeared when adjusted for FFM, presumably reflecting greater skeletal muscle mass in men than in women (Conway et al., 1989).

Early studies of strength and endurance relied on FFM as a surrogate for skeletal muscle mass, but the recent introduction of whole-body multislice magnetic resonance imaging (Heymsfield et al., 1997) and dual-energy x-ray absorptiometry (DXA) provides two important opportunities: the possibility of expanding body composition-functional studies, and the potential of developing anthropometric skeletal muscle prediction models. As an example of skeletal muscle functional studies, Mello and colleagues (1995) evaluated appendicular skeletal muscle mass by DXA and manual material handling in males and females. They observed a significant correlation between muscle mass and lift/carry tasks. Development of anthropometric skeletal muscle mass prediction models has been proposed as a goal for future military research efforts (Friedl, 1997).

Skeletal muscles are all anchored to bones, and the skeleton is an integral component of the anatomical body composition level. The skeleton consists of structural proteins enmeshed in a calcium hydroxyapatite mineral matrix. At the molecular level bone mineral mass and density are evaluated for whole-body or regions using DXA methods. Imaging methods such as magnetic resonance imaging can quantify skeletal mass and dimensions or bone-related components at the anatomical level. The element calcium, found almost entirely in bone, was evaluated in classical skeletal studies using a method referred to as neutron activation analysis. Genetic, dietary, and exercise/training factors all influence the risk of skeletal injuries in the military.

An important body composition concept is that stable relationships exist between some components at the same or different levels. For example, a stable relationship exists in healthy adults between two components at the molecular level, total body water (TBW) and FFM. In populations, the ratio of TBW to FFM is approximately 0.73 (Wang et al., 1992). Stable body

composition associations such as FFM hydration allow development of body composition models. A classic example is that measured TBW can be used to estimate FFM (that is, FFM equals TBW/0.73) and fat (fat equals body weight-FFM). However, individual differences exist in these body composition relationships and some of the observed variation can be explained by age, gender, and ethnicity-related factors. Body composition methods account, to varying degrees, for these small but important between-individual differences and this topic is discussed in the methodology sections below.

Summary

Body weight in relation to stature has been associated with risk for a variety of health conditions as well as with performance ability. A growing consensus among health professionals and agencies that establish guidelines for health promotion and disease prevention supports the use of the BMI as a predictor of morbidity and mortality risk; although the exact range of values that corresponds to the lowest health risks remains the subject of considerable research, a range of 19 to 25 has been adopted by the 1995 *Dietary Guidelines*. Body composition can be described on atomic, molecular, cellular, anatomical, and whole body levels. On the molecular level, the body consists of fat, water, protein, and minerals. The water, protein, and mineral components exist in relatively stable proportions and constitute FFM. At the anatomical level, the FFM component consists of water, skeletal muscle, bone, and the visceral organs. The relatively stable relationships that exist between some components of body composition, such as TBW and FFM, have enabled the development of measurement techniques.

BODY COMPOSITION MEASUREMENT

A brief discussion of body composition assessment methods follows. For the purpose of this discussion, assessment methods will be divided into expedient anthropometric methods, that is, those that can be applied in field situations with minimal equipment; and criterion methods, which require costly and immobile equipment, but the results of which may be used to validate the expedient methods.

Field Methods

Anthropometric methods are suitable for field use as the required equipment is inexpensive, portable, and widely available. Measurements pose no subject risk, and minimal technician training is required.

Once an anthropometric dimension is acquired, the measurement is inserted into a prediction formula and the component of interest is then calculated. The prediction formula is developed by selecting a group of anthropometric dimensions for measurement, often skinfold thickness and circumferences. A criterion method is then chosen for quantifying the component of interest, usually FFM or body fat. A group of subjects is then evaluated for anthropometric dimensions and criterion-derived body composition. Statistical methods are next used to develop

the anthropometric body composition prediction formula. Prediction models are usually developed by setting body fat or FFM as dependent variables and anthropometric measures (such as weight, height, and circumferences), age, and ethnicity as potential independent variables. The last stage of model development is to cross-validate the prediction formula in a new subject group. Prediction formula validity is related to a number of factors, including selected anthropometric dimensions, criterion method accuracy and reproducibility, representativeness of subjects on whom the formula is developed, and statistical modeling methods.

Because visceral adipose tissue is associated with chronic disease risk (as described further below), three anthropometric measures have been suggested as indirect markers of visceral adipose tissue; these are waist circumference, hip circumference, and saggital diameter (Williamson, 1993). A growing number of studies support waist circumference as the strongest visceral adipose tissue correlate among the three, suggesting the inclusion of a measure of adipose tissue distribution in circumference protocols. A waist-hip ratio greater than 0.8, which has been associated with increased upper body strength and performance, is also associated with increased risk for NIDDM, cardiovascular disease (approaching male risk), and certain types of cancer among women.

Military Anthropometric Measurements

Two anthropometric measures have been used by the military: circumferences and skinfolds. Circumferences can be measured with low technical error and a high coefficient of reliability by well-trained technicians (Norton and Olds, 1996). That is, between-measurement and between-observer differences are small for experienced and trained technicians. Skinfolds also can be measured easily, although technical errors are fewer and coefficients of reliability are greater for circumferential measurements (Norton and Olds, 1996). Intra- and interexaminer reliabilities of skinfold thicknesses and circumference measurements were evaluated by Mueller and Malina (1987). The investigators found that circumferences were more reliably measured than skinfold thicknesses (circumferences, 0.97 and 0.96 for intra- and interexaminer reliabilities; skinfolds, 0.94 and 0.92). Additionally, Heaney and coworkers found that circumference measurements were more easily learned than skinfold thickness measurements by active-duty Navy personnel (unpublished report cited by Hodgdon, 1992). Based on circumferences, fat and FFM prediction models have been developed with similar predictive value to skinfold-based prediction models (Katch and McArdle, 1973).

The development of body fat equations for each service has been reviewed by Hodgdon (1992). As described earlier, the Marine Corps was the first service to develop and use circumferential estimations of body composition. Marine Corps equations were developed by Wright and coworkers of the Institute of Human Performance in Fairfax, Virginia, using a sample of (279 male and 181 female) Marine Corps personnel (Wright et al., 1980, 1981). The equations were standardized against underwater-weighing and compared to assessments based on skinfold measurements of the same individuals.

The Army equations were developed by Vogel and coworkers (1988) on an ethnically diverse sample of 1,392 Army personnel (1,126 men and 266 women) who otherwise did not reflect the profile of the total Army population with respect to any demographic variables. A total

of 38 anthropometric measurements was obtained on each subject and equations were constructed using factor analysis to determine the most predictive sites for measurement. The equations were standardized against the method of underwater weighing. Friedl (1997) has noted that the female equation was validated on a largely Caucasian population because of methodological problems with the underwater weighing of many of the African American and Hispanic subjects. The body fat standards originally adopted by the Army were those recommended by the DoD panel in 1981 because of their relationship to fitness.

The Navy equations were developed using a similar procedure and a sample of Navy personnel (Hodgdon and Beckett, 1984a, b). According to Hodgdon and Beckett, the Navy body fat standards themselves were actually established by deriving regression equations for body fat as a function of height and weight for a sample of 1,354 Navy personnel, and then calculating the body fat that would be expected for individuals whose weights fell at the cut-off for obesity defined by the 1985 National Institutes of Health Consensus Conference on the health implications of obesity (these weights were 20% above the midpoint weights for individuals of medium frame size according to the 1983 Metropolitan Life Insurance tables). The mean value for critical percent body fat across all heights was 33.5 ± 0.2 for women; to this figure was added approximately one standard error for body composition measurement using the Navy equations and the resulting figure of 36 percent was adopted as the upper limit for percent body fat for women. Thus the Navy body fat standards were actually based on considerations of health.

As described above, the first Air Force equations included a measurement of the flexed biceps circumference as an index of FFM. The use of these equations, which were developed using a mixed sample of military and civilian personnel (197 men and 38 women), has since been abolished in favor of a slight variation of the Navy's equations (AFI 40-502, 1994).

Anthropometric prediction equations are population specific, and ideally, evaluated subjects should be similar to those from whom the specific equation was developed. Because of gender, age, ethnic, and occupation/task variability within each branch of the military, development and subsequent application of the equations must consider this heterogeneity and, optimally, be applicable across all servicemen and women. Results of an unpublished study described by Friedl (1996), which found that the Army equation was no better than BMI at predicting women's body fat, would seem to call into question the value of assessing body fat among active-duty women. However, these results are not supported by other studies that found a strong relationship between the Marine equation's prediction of body fat (Wright et al., 1980) and criterion measures; a strong relationship between the body fat predicted by all three equations and criterion measures (Hodgdon, 1992); and a stronger relationship between circumference-derived body fat and physical fitness than that between weight-for-height and fitness in both men and women (Conway et al., 1989). Friedl (1997) acknowledges that the predictive ability of circumferential equations for women can be improved significantly with alternative methods of subject selection and choice of a criterion method for validation.

A separate but related issue is that of military service-specific equations. In support of the concept of a common body composition equation among the services, Friedl and Vogel (1997) recently demonstrated that each of the service-specific equations (for males) provided similar results in male soldiers across the services, but the female equations did not provide similar estimates of body fat for female soldiers across the services. A study by Westphal and coworkers

(1995) of women in Army basic combat training compared the ability of the four female equations currently in use to predict changes in body composition over the 8-wk period of basic training and to assess the women's compliance with body fat standards. Each of the four equations resulted in significantly different predicted body fat for the same women. The Marine Corps equation predicted the lowest body fat, suggesting that although the Marine Corps upper limit for body fat is lower than those of the other branches, use of its equation would ultimately result in the retention of a population of women who had the same approximate maximum body fat as that of women in the other services. The Navy equation overpredicted body fat of women with greater upper body strength (those able to lift more than 100 lb [45 kg]), in part because of the increased abdominal circumference of these women. Comparing the circumferential measures of all four services, Westphal and coworkers (1995) found wrist and abdominal circumference to be the best independent correlates of body fat; however, comparing the individual components of the equations used by each service showed hip circumference (used by the Army, Navy, and Air Force) to be the best. Both the Navy and Air Force perform a measure of waist circumference, the Marine Corps measures abdominal (navel) circumference, and the Army measures neither. In this study, waist and abdominal circumference were not strongly correlated with measured body fat; other research with Army subjects has shown that the correlation between abdominal fat and total body fat is significant only in the fattest women (Vogel and Friedl, 1992a).

Criterion Methods

An important aspect of developing anthropometric body composition equations is standardization against a reference or criterion method. Ideally, the selected criterion method should be accurate and precise in heterogeneous populations that vary in age, gender, and ethnicity. In the past, all military branches have used underwater weighing as the reference method to partition body weight into fat and FFM. The underwater weighing two-component model is based on assumed constant densities of fat and FFM. However, as discussed further below, evidence is mounting that water, protein, and mineral FFM fractions may vary considerably among individuals. They may also vary systematically between genders and among age- and ethnic groups (Lohman, 1992). Because the percentage of female and non-Caucasian soldiers is increasing (see Table 2-3 for current ethnicity distribution), and the average age of female soldiers is increasing, the subject population used to develop and validate the military equations (a predominantly young, Caucasian population) is becoming increasingly less representative of the military population whose body composition the equations are being used to predict. Furthermore, questions persist regarding the ways in which underwater weighing is performed and technical problems are overcome (for example, determination of residual volume) (McArdle et al., 1996). Finally, longitudinal studies have shown that underwater weighing does not reliably measure small changes in body composition.

An improved three-compartment model that accounts for the water component of fat-free body mass was suggested by Siri in 1961. Siri's three-compartment model is based on measured body weight, body volume, and body water. Fat estimates using this model are less vulnerable to hydration variation than are those using the classic two-compartment model.

TABLE 2-3 Ethnicity of U.S. Military Personnel by Branch and Rank as of September 30, 1996

	Enlisted (%)				Officer (%)			
Ethnicity	Army	Air Force	Navy	Marine Corps	Army	Air Force	Navy	Marine Corps
Caucasian	42	65	58	59	70	82	82	83
African American	48	25	31	25	20	10	9	9
Hispanic	4	4	8	11	3	2	2	4
Other	2	2	1	2	5	5	4	2

SOURCE: Defense Manpower Data Center (Rosslyn, Va., 1996).

In the past decade, several four-compartment models were developed that extend the three-compartment model by including bone mineral estimates. In healthy, weight-stable ethnically similar subjects within the same age range, two-, three-, and four-compartment models would all be expected to provide similar fat estimates. In disease, unstable conditions, or when applied across broadly ranging subject groups that differ in age, gender, and race, the four-compartment methods usually provide fat estimates with improved accuracy. For example, the two-compartment model would provide less accurate estimates of body fat in a patient with liver disease, ascites, and bone demineralization than would a four-compartment model. African American and Caucasian subjects differ in bone mineral, and this variation is not accounted for in two- and three-compartment models. The major advance that has made the choice of these models possible is the ready access to TBW and bone mineral estimates in addition to several approaches for measuring body volume. The four-compartment method is widely used as a reference for body fat estimation when developing other body composition methods, and agreement now exists that, compared with earlier two-compartment methods, four-compartment methods are superior reference standards for fat and FFM estimation in heterogeneous populations (Heymsfield et al., 1996; Withers et al., in press).

A typical molecular four-compartment study requires several hours for completion, usually beginning with isotope dilution (either by $^{2}H_2O$, $^{3}H_2O$, or $H_2{}^{18}O$) for TBW and measurement of body weight. Underwater weighing for body volume and DXA studies for bone mineral estimation then follow. Four measured variables, TBW, body weight, body volume (underwater weighing), and bone mineral mass (DXA) are then used to calculate total body FFM and fat.

An important recent advance in body composition measurement is the use of DXA alone to estimate body composition (IOM, 1997). DXA has primarily been used clinically for the measurement of bone mineral content and bone mineral density to assess the risk for osteoporosis. DXA entails scanning the body with x rays of differing energies; the attenuation of these rays by body tissues is subjected to computer analysis to yield a three-component estimate of total bone mineral mass, total body fat-free soft tissue, and body fat. As a means of measuring body composition, DXA appears to be more precise and reproducible than underwater weighing when repeated measurements are made over 1 day in the same subject, resulting in coefficients of

variation of about 1 percent for total-body bone mineral, 2 percent for fat-free soft tissue, and 0.8 percent for fat (Kohrt, 1997). DXA is also more convenient to use than underwater weighing for both the subject and the investigator. In addition, DXA yields information about regional body composition and has the advantage of producing results that are independent of ethnic differences if the software allows. Most DXA systems with appropriate software are capable of estimating whole-body and regional bone mineral, body fat, and fat-free soft tissues. Because extremity fat-free soft tissue is mainly muscle, except for a small amount of skin and connective tissue, DXA also is capable of providing appendicular skeletal muscle mass estimates as was demonstrated by Mello and colleagues (1995).

Friedl (1997) notes that DXA is more convenient in large-scale military field research studies and has better reproducibility than underwater weighing (±0.5% vs. ±1.0% body fat). He further notes that the accuracy of the DXA soft tissue analysis compares well with the four-compartment model for male and female soldiers (Friedl, 1997). Additionally, comparisons of DXA results with body fat estimates from anthropometry or total-body potassium also produced good results. While DXA shows much promise in its ability to assess fat accurately, measurements of FFM are susceptible to changes in hydration status and protein content as well as an inability to analyze the composition of soft tissues close to bone, requiring further refinement of this methodology. At present, the regional assessment of body composition by DXA is inferior to that of magnetic resonance imaging and computerized tomography.

Although some concern still exists regarding the calibration of DXA and other technical issues, there is little question that within the next several years it too may serve as a practical reference method. Preliminary evidence suggests that the military is considering DXA as a reference method in the future; the feasibility of this will increase after cross-validation has been performed against accepted multicomponent reference methods.

Summary

Since the mid-1980s, the military has used anthropometric equations to assess body fat in soldiers. Each service has derived its own gender-specific equations, standardized against the criterion method of underwater weighing, a two-compartment method whose measurements are influenced by ethnic and age-related differences in FFM. The populations of active-duty soldiers used to validate the equations have, with time, become less representative of the ethnic and age-diversity of the current military population. The need to ensure readiness without discrimination on the basis of ethnicity or age, or exclusion of the strongest soldiers has led the military to pursue improvement in expedient methods of body composition assessment, particularly as applied to women. Proposed improvements have included development of a DXA-based body composition assessment protocol as a criterion method. An additional question faced by the military is whether one circumferential equation can be developed and applied to all active-duty servicewomen. While agreement among the service-specific equations for men has been good, this has not been true for the equations applied to women.

FACTORS AFFECTING BODY COMPOSITION

Body Composition and Age

Most investigators agree that body weight becomes progressively more difficult to maintain with age. As an example of this phenomenon, Williams (1997) recently argued that body weight and associated circumferences will increase with advancing age unless food intake is significantly reduced or physical activity levels are substantially increased (even in otherwise active individuals). Nevertheless, the Dietary Guideline Committee (1995) could find no rationale to liberalize the upper BMI range consistent with good health as individuals increase in age.

A large number of cross-sectional studies demonstrate an increase in fatness (percent body fat) with age, independent of body weight change, in women (Forbes, 1987; Gallagher et al., 1996b). In a study of non-exercising civilian women, the mean percent body fat of women with BMI of 25 increased from 30 between the ages of 17 and 20 to 34 for women 40 and older (Table 2-4) (Gallagher et al., 1996a). The implication of this is that lean body mass decreases with age.

Currently, the Army and the Air Force set their body fat limits according to age, while the Navy and Marine Corps standards are age-independent. The maximum body fat for Army women increases from 30 percent for women between the ages of 17 and 20 to 36 percent for women 40 and older. The Air Force sets an upper limit of 28 percent for women 29 years or less and 32 percent for women 30 and older. To date, no longitudinal studies have been performed with career military personnel to examine the effect of body weight standards on long-term weight and body fat stability in these individuals.

Genetic Influences on Body Composition

Adoption and twin studies that have assessed the relationship between body composition and genetics (Bouchard, 1996, 1997) have provided heritability estimates that are quite varied. In studies of monozygotic twins, BMI heritability estimates were reported in the range of 40 to 70

TABLE 2-4 Effects of Age on Relationship between Body Mass Index* and Percent Body fat

Age (years)	Body Mass Index	Percent Body fat
17–20	25	30
21–27	25	31
28–39	25	32
40+	25	34

* Weight in kilograms divided by the square of height in meters.

SOURCE: Adapted from Gallagher et al. (1996a).

percent while those from adoption studies grouped around approximately 30 percent or less. Nuclear family evidence from epidemiological studies provided a broad heritability of approximately 40 percent. When several types of relatives are joined in the study design, the heritability estimates fall into the range of 25 to 40 percent.

The effect of environmental factors on the genetic control of body composition has been investigated by under- and over-feeding studies. The results indicate that there are as yet undetermined synergistic effects of genetics and environment on body composition (Rosenbaum et al., 1997).

Ethnic Differences in Fat-Free Mass

The most well-documented difference in body composition between Caucasians and other ethnic groups, particularly African Americans, is an increased density of FFM in non-Caucasians that is reflective of a heavier and denser skeletal mass. The increase in bone mass observed among African American women compared to Caucasian women is due to total body bone mineral mass and greater appendicular lengths, and has been observed across the entire adult lifespan (Gallagher et al., 1996b). The mechanisms that account for these differences, which appear to involve genetic regulation of vitamin D receptor metabolism, were reviewed by Wood (1996) and are presented in the workshop summary (Appendix A). As will be discussed below, the validity of methods of body composition assessment that are based on an assumption of constant bone density among all ethnic groups is called into question by the finding of differences in bone mineral density in some populations.

Ethnic Differences in Total Body fat and Fat Distribution

Increasing evidence suggests that total body fat as well as regional fat distribution are influenced by genetic factors and that these are important factors to consider in describing population differences. The striking increase in the prevalence of obesity in the last decade measured in NHANES III (Kuczmarski et al., 1994) occurred disproportionately among Mexican American (46.7%) and non-Hispanic African American women (48.6% compared with 32.9% for Caucasian women).

In a review of ethnic differences in percent body fat and fat distribution, Gasperino (1996) concluded that percent body fat of African American women was lower than that of Caucasian women. This finding was confirmed by Aloia and coworkers (1997) who compared percent body fat in 23 pairs of African American and Caucasian women matched for height and weight. In contrast to these findings, however, two other studies reported no difference between African American women and Caucasian women with respect to percent body fat adjusted for BMI over a range of ages (Gallagher et al., 1996a) and percent body fat adjusted for body size among girls 3 to 18 years of age (Ellis et al., 1997). In the latter study, percent body fat of Hispanic girls exceeded that of Caucasian girls. Thus, no clear picture emerges from recent studies regarding ethnic differences in percent body fat of women, possibly due to differences in measurement methodology.

The possibility of ethnic differences in body fat distribution in the United States has also been studied (Conway, 1995). Several studies have reported that upper body fat of African American women is greater than that of Caucasian women of similar BMI (Adams-Campbell et al., 1990; Burke et al., 1992; Zillikens and Conway, 1990). In addition, the waist-hip ratio of African American women has been reported to be greater than that of Caucasian women in several studies (Croft et al., 1996; Gasperino, 1996), while others have reported no difference or smaller waist-hip ratio among African American women (Conway et al., 1995; Stevens et al., 1994; Thomas et al., 1997; Yanovski et al., 1996). Stevens and coworkers (1994) also found the average waist/midarm circumference ratio to be lower in a group of 242 African American women than in 312 Caucasian women. Studies comparing distributions of visceral and subcutaneous adipose tissue between African American and Caucasian women have found lower levels of upper-body visceral adipose tissue in 9 African American women compared to 11 of their Caucasian counterparts (Conway et al., 1995); lower levels of total, visceral, and subcutaneous adipose tissue in 20 normal weight African American girls compared to 20 Caucasian girls (Yanovski et al., 1996); and finally lower visceral adipose tissue and visceral-subcutaneous adipose tissue ratios for a given waist-hip ratio when adjusted for total body fat among 25 African American women compared with 25 Caucasian women (Albu et al., 1997). The reasons for these discrepancies among studies is not known but may be associated with methodological differences. However, Thomas and coworkers (1997), who found that African American women had the smallest waist-hip ratio but the largest waist and gluteal circumferences among 143 women of four ethnic origins (Caucasian, African American, Hispanic, and Native American), also showed that the variation within each ethnic group exceeded the variation between groups such that it was not possible to predict a woman's ethnic origin based on body fat distribution (waist-hip ratio).

Implications of ethnic differences in body fat distribution. Differences in body fat distribution, particularly increases in waist-hip ratio, suggestive of increased deposition of intra-abdominal fat, have been associated with an increase in risk for particular diseases, but these same waist-hip ratio differences are associated with greater upper body strength in women. Similarly, as discussed above, because all military services currently employ circumferential methods of body fat prediction (standardized against underwater weighing) to determine qualification for accession into and retention in the armed forces, ethnic differences in total bone density or regional body fat deposition could potentially favor one ethnic group over another, although no data were found to suggest that this has occurred.

Summary

While there is little disagreement that body weight maintenance becomes more difficult with increasing age, current guidelines do not suggest relaxing the upper BMI limit that is believed to be consistent with good health, for older individuals. Research also suggests that percent body fat increases with age, independent of change in body weight. The Army and Air Force body fat standards make allowances for age-associated increases in body fat, while those of the Navy and Marine Corps do not. Estimates of heritability of BMI range from 25 to 40 percent.

Studies suggest that genetics and environmental factors interact synergistically to influence body composition. The most well-documented difference in body composition attributable to ethnic variation is that of increased skeletal density among African American women relative to Caucasian women. Ethnic differences in total body fat and fat distribution have been more difficult to demonstrate, with some studies showing clear differences and others showing greater within-group than between-group variation. The issue of ethnic differences in FFM and body fat distribution has significant implications for the design of anthropometric equations to assess body fat in military women as well as the choice of a criterion method to validate those equations.

INFLUENCES OF BODY COMPOSITION ON HEALTH, FITNESS, AND APPEARANCE

Body Composition and Health

Body Fat Distribution

Evidence for a relationship between body fat as indicated by BMI and health risk was presented earlier. There is abundant evidence that fat or adipose tissue distribution also influences health. A number of the health risks associated with overweight may be more strongly related to the pattern of body fat distribution than to total fat. Individuals with an excess accumulation of abdominal fat appear to be at increased risk for cardiovascular disease, hypertension, and NIDDM (Bouchard, 1988; Wing et al., 1992). Results of the *San Antonio Heart Study*, for example, which included 491 Mexican American women, demonstrated that while waist-to-hip ratio and BMI were both predictors of risk for NIDDM, waist-to-hip ratio was actually a stronger predictor (Haffner and Bauer, 1992). Gender differences in insulin resistance are clearly related to differences in waist-to-hip ratio (Laws et al., 1997).

Evidence also has suggested, however, that increased waist-to-hip ratio may not be as strong a risk factor for disease in non-Caucasians as it is for Caucasians. Dowling and Pi-Sunyer (1993) reported that African American women with upper body obesity as defined by increased waist-to-hip ratio had less insulin resistance and glucose intolerance, and lower serum triglycerides than Caucasian women of comparable upper body obesity. Results of the *Insulin Resistance Atherosclerosis Study*, a large multicenter study of NIDDM and cardiovascular disease risk in African Americans, Hispanics, and Caucasians, have also suggested that upper-body obesity, independent of total body fatness, may be a greater risk factor for Caucasians than for non-Caucasians (Karter et al., 1996). More research in this area is clearly needed. Pending the results of additional body composition-clinical outcome studies, most investigators currently use BMI as a measure of health risk.

Body Composition and Risk for Injury

Another aspect of health risk of considerable interest to the military and one that has been examined in relation to body composition and BMI is injury risk. A weak association was re-

ported in the review of Jones and coworkers (1994) between BMI and exercise-related injuries, including stress fracture of the lower extremities. Some support exists for a bimodal relationship between BMI and injury risk, with subjects who have either high or low BMIs at greater injury risk.[1] In their study, Jones and coworkers (1992) reported a gender difference in injury risk, with men showing the aforementioned bimodal distribution related to BMI while risk was significantly increased only in women with low BMI. The authors hypothesized that injury-prone women with low body fat may not have adequate FFM to support their weight without "undue stress." Kowal (1980) has published data on the nature and causes of women's injuries that occurred as part of an endurance training program. Higher weight and percent body fat, possibly secondary to lack of prior fitness, were significantly related to increased incidence of injury during training.

Body Composition and Fitness

Fatness influences fitness because excessive adiposity may add a functionally inert component of weight that must be carried during various physical activities. According to Friedl (1997), the absence of grossly obese soldiers has limited the ability of the military to demonstrate strong relationships between fatness and physical performance. Nevertheless, when Conway and colleagues (1989) examined the association between circumference-derived fatness measures in Navy men and women and measures of physical fitness, significant negative correlations were observed between fatness and physical fitness measures that tended to be greater in magnitude than the associations observed between body weight/height indices and physical fitness. In another study of Navy personnel, Beckett and Hodgdon (1987) evaluated fatness in active-duty women and found a negative association between underwater weighing-derived fat mass and two measures of fitness and endurance: box carrying capacity and running performance. A study of male and female Canadian Forces troops (for whom BMI was used as an index of body fat until body fat standards were eliminated in 1992[2]) found a strong association between increasing BMI (> 25) and decreasing fitness and performance (except for grip strength) (Jette et al., 1990). The complex associations among fatness, fitness, and health are demonstrated by the study of Marchitelli and colleagues (1995), in which women who exceeded the fat standard after 8 weeks of basic combat training had lower high density lipoprotein levels, increased cardiovascular risk, and significantly increased 2-mi run times (that is, lower endurance) but were significantly stronger (as measured by performance on machine lift and bench press, for example) than their less fat counterparts. A potential explanation for greater strength accompanying increased levels of fatness is that heavier women may have a larger FFM.

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[1] At present, Army Regulation 600-9 (1986) sets age-neutral, height-specific lower limits for body weight at accession. However, these lower limits correspond to BMIs ranging from 18.8 for the shortest to 16.9 for the tallest women.

[2] In 1992, the Canadian Forces were required to abolish their Weight Control Program on the grounds that it violated the Canadian Human Rights Act; a policy review had found insufficient link between excessive individual weight and lack of essential physical fitness.

Khosla and McBroom (1984) calculated BMIs for 824 female Olympic finalists from 47 events included in the 1972 and 1976 Olympics (Table 2-5). Gymnasts and rowing coxswains had the lowest BMIs: the BMIs of gymnasts averaged 18.6 to 18.7 and ranged from 16.0 to 20.0, while the BMIs of coxswains averaged 18.6 and ranged from 15.8 to 29.8. Not surprisingly, shot putters and discus throwers had the highest BMIs: shot putters' BMIs averaged 28.1 (range 23.9 to 31.1) and discus throwers' BMIs averaged 28.4 (range 23.6 to 34.7). Women who competed in activities requiring all-around strength and endurance, that is those involved in the pentathlon, canoeing, handball, rowing, swimming, and volleyball, demonstrated average BMIs of 18.6 to 25.9. Thus, it may be argued that women with BMIs ranging from 16 to 35 have demonstrated extreme physical fitness. These data suggest that while all-around fitness may be associated with a BMI range of 19 to 26, women of BMI as high as 35 and as low as 16 have demonstrated excellent athletic performance.

In several large epidemiological studies (Blair et al., 1989; Paffenbarger et al., 1986), decreased mortality and morbidity risk have been shown to correlate more closely with activity level than body fat. According to these findings, it is possible to be active and fit, with a low health risk, and still be fat by the body fat standard.

Body Fat Standards Versus Fitness Standards

It is generally acknowledged that increasing body fatness is associated with lowering of weight-bearing endurance performance while increasing lean mass, often accompanied by greater body fat and weight, is compatible with greater strength (IOM, 1992). Setting a high body fat limit thus favors selection of women who are strong but lack optimum endurance and vice versa, thus creating a paradox.

Additionally, within any BMI or percent body fat range, women will vary greatly in overall "fitness." Hence two women of the same fatness can have very different lifting capacity or ability to complete a 2-mi run. According to Jones et al. (1992), body composition explains only 5 to 30 percent of between-individual differences in endurance performance and other factors such as sit-ups and vertical jumps. As fitness is a key component to military readiness, fitness standards must be considered in conjunction with standards of body weight and composition. This will be discussed in greater detail in Chapter 3.

Body Composition and Appearance

With respect to the role of body composition in appearance, two aspects of body composition prevail; these are total fatness and fat distribution. Both excessive thinness and overweight may be associated with an undesirable military appearance. Localized accumulations of adipose tissue associated with excessive weight gain, such as adipose tissue deposited within the abdominal cavity or around the hips and thighs, may also influence overall appearance. References to the appearance standard in military directives describe it predominantly in terms of ab-

TABLE 2-5 Mean Body Mass Index (BMI) of Female Olympic Athletes, 1972–1976

Event	*n*	Mean BMI* ± SD	Range
Archery	10	21.7 ± 1.4	19.3–23.8
Athletics 100m run	15	20.9 ± 2.1	18.4–24.3
Athletics 200m run	15	20.5 ± 1.8	18.4–24.3
Athletics 400m run	16	19.6 ± 1.0	17.3–21.0
Athletics 800m run	16	20.0 ± 1.4	17.5–22.5
Athletics 1,500m run	18	19.0 ± 1.1	17.6–20.8
Athletics 100m hurdles	16	21.3 ± 1.0	20.3–23.3
Athletics high jump	16	20.6 ± 0.8	19.3–21.6
Athletics long jump	16	20.6 ± 1.0	19.3–21.8
Athletics shot	16	28.1 ± 2.4	23.9–31.1
Athletics discus	16	28.4 ± 3.1	23.6–34.7
Athletics javelin	15	23.3 ± 1.4	21.1–25.8
Athletics pentathlon	16	22.3 ± 1.9	20.2–26.8
Basketball	36	22.5 ± 2.0	19.0–29.0
Canoeing kayak 1	22	22.8 ± 1.6	20.3–25.3
Canoeing kayak 2	36	23.2 ± 1.3	19.4–25.2
Canoeing kayak 3	8	22.7 ± 1.5	20.9–25.0
Equestrian dressage	12	20.0 ± 2.1	18.2–25.4
Equestrian 3 day	1	21.0	N/A
Equestrian jumping	2	21.2 ± 0.4	20.9–21.5
Fencing foil	18	22.0 ± 1.6	18.6–24.2
Gymnastics beam	13	18.5 ± 1.3	16.0–20.0
Gymnastics floor	18	18.7 ± 1.2	16.0–19.9
Gymnastics vault	12	18.6 ± 1.3	16.0–19.9
Gymnastics asymmetric bars	12	18.6 ± 1.3	16.0–20.0
Hand ball	42	22.8 ± 1.4	20.0–25.9
Rowing sculls single	11	22.4 ± 1.5	18.2–24.1
Rowing sculls double	12	22.4 ± 1.4	20.1–24.9
Rowing coxless pairs	12	23.0 ± 1.8	21.1–25.1

Continued

TABLE 2-5 *Continued*

Event	*n*	Mean BMI* ± SD	Range
Rowing coxed quad†	30	23.1 ± 1.6	21.0–25.6
Rowing coxed fours†	30	23.9 ± 1.9	21.2–28.7
Rowing eight†	27	24.1 ± 2.5	20.6–28.1
All coxswains	15	18.6 ± 1.5	15.8–29.8
Swimming 100m f.s.	15	21.1 ± 1.4	18.0–23.3
Swimming 200m f.s.	14	21.0 ± 1.5	18.0–23.3
Swimming 400m f.s.	13	20.5 ± 1.3	18.0–22.0
Swimming 800m f.s.	15	20.7 ± 1.4	18.1–23.2
Swimming 100m back stroke	15	21.0 ± 1.6	17.3–22.8
Swimming 200m back stroke	15	20.6 ± 1.4	17.9–22.5
Swimming 100m breast stroke	16	21.5 ± 1.9	19.4–26.2
Swimming 200m breast stroke	16	21.9 ± 1.7	20.3–26.2
Swimming 100m butterfly	16	21.6 ± 1.4	19.7–24.1
Swimming 200m butterfly	16	21.2 ± 1.6	19.4–24.1
Swimming 200m medley	7	21.3 ± 1.0	20.1–22.5
Swimming 400m medley	9	20.5 ± 1.3	18.1–22.2
Swimming spring dive	16	20.1 ± 0.9	18.0–22.1
Swimming platform dive	16	20.6 ± 1.5	18.7–25.1
Volleyball	70	23.1 ± 1.7	20.0–30.1

* Originally listed as *bulk index* (g/cm^2; BMI, kg/m^2).

† Physical characteristics of coxswains are excluded in calculating mean and standard deviation (SD); details on all coxswains are listed separately.

SOURCE: Adapted from Khosla and McBroom (1984).

dominal girth (AR 600-9, 1986; Vogel and Friedl, 1992b). Hodgdon, in his review of standards and methods used by the military to assess body composition (1992), emphasized the subjective nature of military appearance assessments. To explore the relationship between military appearance assessments and fatness, Hodgdon and colleagues (1990) evaluated appearance judgments by 11 Navy headquarters staff based on visual inspection and compared these judgments to body fat estimation in 251 female Army personnel dressed in Class A uniforms. Only a modest correlation was observed between appearance ratings and percent fat ($r = 0.46$), leading the authors to conclude that factors other than body composition, notably subjective judgment, influence appearance ratings. In the 1992 Committee on Military Nutrition Research (CMNR) report on *Body Composition and Physical Performance* (IOM, 1992) a presentation by Shephard (1992) raised

the point that in some occupations, image is considered an important aspect of effectiveness, and that because the image of a soldier is one of leanness, an overfat appearance could weaken this image and threaten deterrence; there is no research on this issue. The report itself recommended that if, in spite of the lack of demonstrable association between appearance and task performance, appearance standards were determined to be crucial to military operations, objective evaluation criteria would need to be developed, since violations of the appearance standard that were attributed to excess body fat could have negative career consequences. There is no evidence that objective appearance evaluation criteria have been developed.

Another appearance-related concern is an overemphasis on thinness as a measure of attractiveness, observed in the civilian population, that is often linked with the onset of abnormal eating behaviors and related morbidity in women (see Chapter 4 and summary of Garner's presentation in the workshop summary [Appendix A]). The concern is that issues of appearance may begin to have a negative impact on health and fitness, and therefore maintenance of readiness among military women.

Summary

There is clear evidence for a relationship between body fat distribution and risk for chronic illness among Caucasians, with increased waist-hip ratio predicting an increased risk for NIDDM and cardiovascular disease. Although more research is needed, this relationship appears to be weaker among non-Caucasians. BMI that is significantly higher or lower than the normal range increases the risk for stress fracture among military recruits in basic combat training. The relationship between body composition, physical fitness, and performance is complex: military women who exceed the weight-for-height standards or the body fat standards demonstrate increased performance of some strength tasks, but poorer performance on some tests of aerobic fitness and endurance, possibly the result of larger FFM accompanying increased weight and fatness. Body fat alone cannot be used to predict physical ability. The relationship between percent body fat and subjective judgment of appearance in a military uniform is also not strong.

CONCLUDING REMARKS

According to Friedl, the military assesses weight and body fat as a means to prevent obesity and promote physical fitness by motivation. The methods used to assess body fat must be accurate enough to classify soldiers, must not grossly over- or underestimate the body fat of individuals, and must not discriminate against particular groups because of age or ethnic differences in body composition. The equations currently in use underpredict body fat for individuals of higher body fat and overpredict body fat slightly at the lower end; nevertheless, there is concern that some of the women with greatest physical strength and lifting capability are those most at risk for exceeding the body fat standards and being referred to weight control programs, with significant professional consequences. An additional concern is the variability in comparative body fat estimates rendered by applying each service's equation to the same individuals, suggesting the need for a single equation to be developed for all military women. Anthropometric pre-

diction models can now be optimally derived using criterion methods that are of high technical quality and that are minimally influenced by individual differences in chemical composition. Validation of these methods can include adequate numbers of subjects who have characteristics similar to those on whom the method will ultimately be applied; appropriate anthropometric dimensions obtained by trained observers can be incorporated; and modern statistical modeling approaches can be used to develop and cross-validate the models.

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3

Physical Fitness Policies and Programs

The Department of Defense (DoD) considers physical fitness an important component of the "general health and well-being" and readiness of military troops (DoDD 1308.1, 1981) and defines physical fitness as including cardiorespiratory endurance, muscular strength and endurance, and whole-body flexibility, as well as balance, agility, and explosive power. Annual assessment of these parameters is mandated in DoD Directive 1308.1; remedial (run/walk) programs are provided for those who fail the physical fitness or readiness test (PFT or PRT). However, due to limited training hours, the DoD does not require (but does allow) ongoing physical training during duty hours. The specifics of requirements and testing are left to the individual services, based on their needs and mission. The purpose for instituting this requirement for physical fitness was to ensure an optimum body composition (within body fat standards) and appearance for all military personnel.

At present, a dilemma exists within the military. Optimum physical fitness for readiness, and for performance of the more strenuous job classifications that have been opened to women, requires maintenance of significant strength, endurance, and muscle mass; optimum appearance may require a low body weight, with an associated low fat mass, which may be accompanied by diminished muscle mass. Thus, "readiness" and appearance may not go together or may even be incompatible in some instances.

It has become necessary to evaluate the relative importance of the two reasons for the physical fitness standards in the military, that is, fitness and appearance. Body composition stan-

dards are discussed in Chapter 2. This chapter seeks to investigate the elements of physical fitness and their relationship to health, readiness, and body composition; to explore the present programs and policies in the military and other uniformed (law enforcement and firefighting) service organizations; and to make recommendations for future programs and assessments.

DEFINITION OF FITNESS

In 1994, Bouchard and Shepard proposed a model describing the relationships among physical activity, fitness, and health for the International Consensus Conference on Physical Activity, Fitness, and Health. They defined fitness as "matching of the individual to his or her physical and social environment" (p. 81) (see Figure 3-1) and pointed out that the two goals of fitness were performance and health. Performance-related fitness was proposed to include motor skills; cardiorespiratory power and capacity; muscular power, strength, and endurance; body size; body composition; motivation; nutritional status; and genetics. Health-related fitness was defined as having "an ability to perform daily activities with vigor" (p. 81) and a low risk of developing degenerative diseases. The components of health-related fitness include body composition, strength and endurance, cardiovascular and respiratory function, and intracellular metabolism. Clearly, these two goals of fitness lie on a continuum.

Thus, the issue of physical fitness requirements in the military (or the general population) is twofold. A basic level of physical fitness is required for overall health in all individuals (ACSM, 1990; DHHS, 1991, 1996; International Proceedings and Consensus Statement, 1994; NIH, 1995), and there is a level of fitness required for the optimum performance of one's chosen lifestyle, including occupation and recreational activities.

The civilian literature provides a large body of information supporting the importance of physical activity in overall health and contains a variety of recommendations for amount and quality of exercise required to achieve health and performance-related fitness.

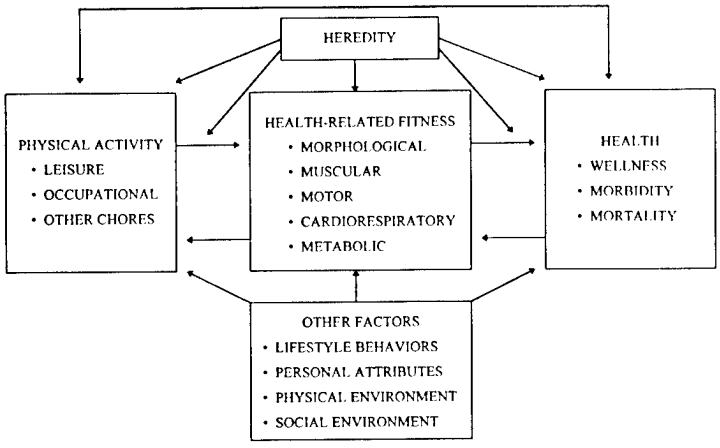


FIGURE 3-1 Relationships among habitual physical activity, health-related fitness, and health status. SOURCE: Reprinted by permission from C. Bouchard and R. J. Shephard (1994), "Physical activity, fitness, and health: The model and key concepts" in *Physical Activity, Fitness, and Health: International Proceedings and Consensus Statement*, edited by C. Bouchard, R. J. Shephard, and T. Stephens (Champaign, Ill.: Human Kinetics), 78.

The American College of Sports Medicine (ACSM) has maintained a position stand since 1978 ("Recommended Quantity and Quality of Exercise for Developing and Maintaining Fitness in Healthy Adults") outlining the amount of exercise shown in an extensive body of literature to be optimum for achieving and maintaining physical fitness in the general population. They differentiate between the amount of exercise needed for general health and the amount needed for improvement in fitness level, as defined by an improvement in maximum oxygen consumption ($\dot{V}O_2max$). In the updated position stand (1990), ACSM recommended the frequency (3–5 times/wk), intensity (60–90% of maximum heart rate), duration (20–60 minutes of continuous aerobic activity depending on intensity), and mode (activity using large muscle groups that can be maintained continuously) of the exercise required for development and maintenance of a level of physical fitness similar to that required by all military troops for readiness. In this version of the position stand, resistance exercise is an added recommendation—conditioning of the major muscle groups at least 2 d/wk to ensure sufficient strength to perform normal activities of daily living, maintain fat-free mass (FFM), and control body weight.

In 1991, the U.S. Department of Health and Human Services published *Healthy People 2000* (DHHS, 1991), in which it indicated one of its goals to be an increase in the activity level of the general population to improve health (Items 1.1 to 1.14). In 1995, the National Institutes of Health convened a consensus conference on physical activity and cardiovascular health at which the participants agreed that a minimum of 30 minutes each day of moderate physical activity (defined as brisk walking) would improve health, and that for most individuals, more exercise of greater intensity would further improve health. This group also agreed that resistance exercise should be incorporated into an ongoing exercise program at least 2 days each week.

In 1996, the U.S. surgeon general (DHHS, 1996) issued a report, *Physical Activity and Health*, outlining and evaluating the literature available, which supports exercise as an important part of an overall program of health, and recommending a minimum of 150 kcal/d of strenuous exercise to protect against the risk of heart disease, colon cancer, hypertension, and diabetes.

Clearly, some disagreement exists among these groups of individuals as to the amount of physical activity required for health. There is a consensus, however, that regular physical activity is part of a healthy lifestyle that is compatible with readiness, and that daily physical activity generally increases health and fitness. Extrapolation to the military situation suggests that a consistently ready, fit, and healthy force is one that routinely engages in at least the level of exercise recommended by the ACSM. In addition, however, military personnel must be ready to perform the maximum requirements of their job specialties at any moment.

Much evidence in the civilian literature supports the need for job-related training. Individuals who routinely practice the highest demand activities of their job description experience fewer injuries during performance of those activities while on duty (Jackson, 1994). Failure to maintain training level results in a very rapid decline in physiological function. Detraining of strength manifests in a decrease in muscle mass in as little as 1 week (Brooks et al., 1996), and endurance capacity can diminish in 2 weeks (Coyle et al., 1984) or less (Hickson et al., 1985). Firefighters, who achieve competence in specific job capabilities during training, have been shown to lose those competencies when they rely on customary day-to-day job activities (Ellam et al., 1994). Studies in both military and civilian sectors show that individuals participating in a routine strenuous activity program experience fewer stress fractures. Thus, to provide for a mili-

tary force ready for deployment at a moment's notice, job-specific physical fitness training must be ongoing.

Summary

Fitness, which has been defined as the matching of an individual to his physical and social environment, has two goals: health and performance. Physical fitness requirements in the military consist of a basic level of overall fitness required for the health of all individuals and a higher level of fitness that is required for the performance of occupational activities. A number of government and civilian organizations have proposed levels of physical activity that they believe are required for health maintenance. Although there is disagreement among these groups regarding the exact amounts required, there is consensus on the need for daily physical activity, both endurance and resistance, in a healthy lifestyle. In addition to this, the military must address the need for ongoing, job-specific performance training.

CURRENT MILITARY PHYSICAL FITNESS STANDARDS, TESTING, AND PROGRAMS

Health-Related Fitness

Evaluating an individual's physical fitness determines his or her appropriateness for military service both at the time of accession (enlistment) and for purposes of retention. Current military fitness tests are a result of work initiated in response to a DoD symposium conducted in 1981 to review the assessment of military physical fitness as a part of readiness. That symposium indicated the following: (1) services could not provide an accurate assessment of the physical fitness of their personnel; (2) services did not provide total physical fitness programs to personnel of all ages and in all military occupations; (3) leadership and expertise in physical fitness were lacking; and (4) current civilian knowledge was not being incorporated into fitness training (DoD, 1981). As a result of this symposium, DoD Directive 1308.1 (1981) was issued (as described on the first page of this chapter); the report also resulted in the formation of a task force and establishment of the Army Physical Fitness School.

Physical fitness testing at the time of an individual's enlistment varies among the services. The Air Force administers a strength test, the incremental dynamic lift test,[1] at the time of enlistment for determination of job qualification. As will be discussed later, this test was also used at one time by the Army, but it has since been discontinued. Neither the Navy nor the Marine Corps performs a similar assessment of physical fitness at enlistment beyond the height/weight and body composition assessments. By the end of basic combat training (BCT), all active-duty personnel are expected to pass the physical fitness test for their branch of service.

[1] The incremental dynamic lift test is a strength aptitude test that uses the incremental lift machine, consisting of a vertically moving carriage with handgrips. The weight of the component that is lifted can be varied from 40 to 200 lb (18–91 kg); the handgrips rest 12 in (30 cm) from the floor and are 16 in (40 cm) apart.

The DoD-mandated physical fitness evaluation for retention also varies among the services (Table 3-1 and Appendix B). The exam for most services includes an evaluation of both cardiorespiratory endurance (1.5- to 3-mi run, cycle ergometer test, or 500-yd swim) and strength (push-ups, pull-ups, sit-ups); as shown in Table 3-1, adjustment of scores for gender or age is not uniform across the services. The Air Force testing differs markedly from the other services in that it requires only a submaximal cycle ergometry test as a determination of aerobic capacity. Passing scores are age adjusted, and lower passing values for women reflect the data showing that $\dot{V}O_2max$ in women is about 10 ml/kg lower than in men for the same body size (McArdle et al., 1996). The validity of this method has been put in question by some studies (Pollock et al., 1994; Williford et al., 1994), which show that the equations used to predict $\dot{V}O_2max$ from submaximal performance underpredict values for men by as much as one fitness level, thus resulting in failure of some aerobically fit individuals to meet the standard.

The frequency of fitness testing varies by service and to some extent within each service. The Army performs its PFT semiannually. A PRT is given to Navy and Marine Corps personnel one to four times a year, depending on the command. The Air Force test is conducted annually. Failure results in referral of a person to a remedial run/walk program.

Data from the military suggest that simply enforcing the PFT has not achieved an improvement in the overall fitness of military troops. In 1988, the Army Physical Fitness School was given the task of measuring the fitness of the active-duty Army. The PFT was administered at a number of Army posts within the continental United States to measure the fitness of a sample of 5,347 males and 676 females in 60 of the 277 military occupational specialties (MOSs, which are classified by strength requirement [see Table 3-2 and Appendix C]). Reasons cited for the high failure rate (Table 3-3) of younger soldiers included less motivation, less training, and deselection of the less-fit soldiers with time in the service. The study concluded that renewed emphasis on physical conditioning, especially of younger soldiers, was necessary (O'Connor et al., 1990).

In 1995, the Army Fitness School repeated the survey of Army personnel fitness (Table 3-3), using a random sample of approximately 3,000 active-duty soldiers stratified by age, gender, and MOS. An apparent gender disparity in fitness was complicated by the result that in women, performances on the 2-mi run and sit-ups reached or exceeded the maximum required for women more often than they did in men; conversely, the push-up event appeared to favor men. The report recommended that (1) effort scales be reconfigured to be equal for both genders, (2) passing scores be relaxed except for those in the two youngest age groups (17–21 and 22–27), (3) minimum aerobic capacity standards be set at the same rating for men and women, and (4) older age groups be established (Tomasi et al., 1995). In response to the results of this survey and its recommendations as well as other information, a proposal is under consideration by the U.S. Army Chief of Staff to modify the requirements for passing the Army PFT. If the modification is approved, the number of push-ups that both men and women will be required to perform will be increased by a small number; women will be required to perform the same number of sit-ups as men; and the time allowance for the 2-mi run will be decreased (to increase stringency) for both women and men (Personal communication, L. F. Tomasi, Fort Benning, Ga., 1997). A decision is expected during the 1998 fiscal year.

TABLE 3-1 Variables or Standards Used by the U.S. Military Services for Assessing Fitness of Personnel

Variable or Standard	DoD Directive/ Instruction	Army	Navy	Air Force	Marine Corps	Coast Guard
Frequency of Fitness Assessment	Formally evaluated and tested at least annually	Semiannual	Semiannual PRT optional for members > 50 years (NAVOP 064/90, 1990)	Annual	Semiannual	At least annual and upon random urinalysis testing
Fitness Test	Annual Adjusted for age and gender Cardiovascular and muscular endurance (DoDI 1308.3, 1995)	Adjusted for age and gender (AR 350-41, 1993) 2-mi run Sit-ups × 2 min* Push-ups × 2 min	Sit-reach Curl-ups × 2 min Push-ups × 2 min 1.5-mi run/walk or 500-yd swim (age and gender adjusted) + BF standards (OPNAVINST 6110.1D, 1990)	Submaximal cycle ergometer test, percent of standard based on $\dot{V}O_2max$, age and gender specific (AFI 40-501, 1996)	Men: 3-mi run Curl-ups Push-ups Pull-ups × 2 min Women: 1.5-mi run Curl-ups Push-ups Bent-arm hang × 2 min	None
Duty Time for Physical Fitness	May authorize 1½ hrs, 3×/wk	Authorize duty time	Commanding officer's discretion	Commanding officer's discretion	Part of weekly training day	Commanding officer's discretion

NOTE: DoD, Department of Defense; PRT, physical readiness test; NAVOP, Naval Operational Message; DoDI, Department of Defense Instruction; AR, Army Regulation; BF, body fat; OPNAVINST, Naval Operations Instruction; AFI, Air Force Instruction. A more detailed table appears in Appendix B.

* Number of sit-ups performed in 2 minutes.

TABLE 3-2 Summary of Job Classification Strength Requirements for Enlisted Women in the U.S. Military Services as of September 1996

	Branch of Service		
Strength Requirement	Army	Navy	Air Force
Very heavy*			
Percent OCC classifications in this strength category	41.4%	23.9%	5.7%
Total number of women in this strength category	17,617	3,889	226
Percent women in this strength category	32.7%	11.3%	<1.0%
Heavy†			
Percent OCC classifications in this strength category	14.8%	20.9%	NA
Total number of women in this strength category	9,269	6,157	NA
Percent women in this strength category	17.2%	17.8%	NA
Moderate‡			
Percent OCC classifications in this strength category	22.2%	9.0%	11.4%
Total number of women in this strength category	15,535	7,207	4,404
Percent women in this strength category	28.9%	20.9%	8.6%
Medium§			
Percent OCC classifications in this strength category	16%	4.5%	27.8%
Total number of women in this strength category	9,619	2,053	13,593
Percent women in this strength category	17.9%	5.95%	26.5%
Light‖			
Percent OCC classifications in this strength category	56.0%	41.7%	55.1%
Total number of women in this strength category	1,780	15,178	32,997
Percent women in this strength category	3.3%	44.0%	64.4%
Total enlisted women with assigned MOSs	53,820	34,484	51,220

NOTE: More detailed tables appear in Appendix C. For Marines and Coast Guard, job classifications are not subject to strength testing; therefore, strength level categories cannot be assigned. As female military personnel are not permitted to serve in designated combat or combat-related assignments, these military occupational specialties have not been included in this table. OCC, occupational classification; MOS, military occupational specialty.

* Army defines very heavy strength requirement as ability to lift on occasional basis over 100 lb (45 kg) with frequent or constant lifting in excess of 50 lb (23 kg). Corresponds to Navy's high/high and Air Force's high strength requirements. † Army defines heavy strength requirement as ability to lift on occasional basis a maximum of 100 lb (45 kg) with frequent or constant lifting of 50 lb (23 kg). Corresponds to Navy's high/moderate strength requirements. ‡ Army defines moderate heavy strength requirement as ability to lift on occasional basis a maximum of 80 lb (36 kg) with frequent or constant lifting of 40 lb (18 kg). Corresponds to Navy moderate/moderate strength requirements. § Army defines medium strength requirement as ability to lift on occasional basis a maximum of 50 lb (23 kg) with frequent or constant lifting in excess of 25 lb (11 kg). Corresponds to Navy's moderate/low and Air Force's moderate requirements. ‖ Army defines light strength requirement as ability to lift on occasional basis a maximum of 20 lb (9 kg) with frequent or constant lifting of 10 lb (5 kg). Corresponds to Navy's low/moderate and low/low and Air Force's low requirements.

SOURCE: *Army*: Adapted from Sharp et al. (1980) and MAJ Kurt Berry (U.S. Total Army Personnel Command, Alexandria, Va.); *Navy*: Adapted from DoD 132.1-1 (1995) by LT Leslie Cox (Bureau of Naval Personnel [BUPERS], Washington, D.C.) and Ross Vickers (Naval Health Research Center, San Diego, Calif.). Air Force: Adapted from Air Force Specialty Code, including Air Force Manual 36-2108 (1994), attachment 39, by MAJ Joanne M. Spahn (Nutritional Medicine Service, 3rd Medical Group/SGSD, Elmendorf AFB, Alaska).

TABLE 3-3 Failure Rate of Army Personnel on Physical Performance Tests

	Study Date 1988*		Study Date 1995†	
	Age (years)	Failure (%)	Age (years)	Failure (%)
Males	18–21	29	All ages	11.4
	22–31	17	17–26	26.8
	32–51	11	> 27	7.4
	>52	17		
Females	18–21	36	All ages	13.4
	22–26	18	17–26	32
	>26	10	> 27	9.1

* $N = 5,347$ males; 676 females.
† $N = 3,000$.

SOURCE: Adapted from O'Connor et al. (1990) and Tomasi et al. (1995).

It is widely acknowledged that the periodic military fitness tests establish a minimum level of fitness (the Army PFT was based on an arbitrary, perceived level of fitness needed for Army task performance [Vogel, 1992]). Nevertheless, the results of the study by Tomasi and coworkers (1995) suggest that even this level of fitness is not achieved by a significant number of Army personnel. Although a comparable recent survey of Navy personnel was not identified, it is known that in fiscal year 1996, 658 enlisted personnel and 24 officers were separated from Navy service for failure to pass the physical fitness portion of the Navy PRT (Personal communication, LCDR R. Hernandez, Bureau of Naval Personnel [BUPERS], Washington, D.C., 1997). A 1991 report (Destadio, 1991) suggested a similar lack of fitness among Air Force personnel throughout the 1980s.

Studies of fitness in military women are sparse. An overview of physical fitness in female cadets at the various military academies (Baldi, 1991) suggested that women entering the military academies have been increasingly fit, and that basic training can increase that fitness significantly, especially in those who were less fit at the beginning of training. Consequent to the improvement in performance by women, modifications in the physical fitness tests have been proposed by some branches of the service (Navy, Army) so that men and women will be required to perform more similarly on strength-related tests.

However, injury rate in women both in basic training and field maneuvers is greater than that in men (Jones et al., 1992; Moore, 1996). Jones and coworkers (1992) have studied injuries among men and women in Army basic training over a 10-y period, assessing the factors contributing to injury risk. They have found that women have a higher risk of all types of lower-extremity, musculoskeletal injury than men, including stress fracture of the tibia. This increased risk was associated with higher or lower than average body mass index (BMI), but there was no relationship between injury risk and body fat in women. Previous exercise experience or aerobic

fitness (Jones et al., 1993) was found to be an important factor in injury risk in women. Other studies of stress fractures in women suggest that adequacy of energy intake may also be a factor in predicting injury risk (Marcus et al., 1985).

Ongoing Physical Fitness Training in the Military

As emphasized by Knapik (1996) at a symposium on physical performance in the military, the maintenance of physical fitness requires regular periods of physical training of sufficient frequency, duration, and intensity. The DoD supports ongoing physical training as a means of passing the PFT/PRT (DoDD 1308.1, 1981). At present, each service interprets this policy independently (see Table 3-1). Only the Army and Marine Corps have policies that includes fitness training as part of duty time; the other services leave authorization of physical fitness training during duty time to the commanding officer of each facility, and thus implementation is intermittent.

Army Regulation 350-41 (1993) mandates vigorous physical activity three to five times per week during normal duty hours, and the Army has established the U.S. Army Physical Fitness School at Fort Benning, Georgia (formerly at Fort Benjamin Harrison, Indiana), which trains 2,000 to 3,000 master fitness trainers each year to work with troops to develop ongoing fitness programs and perform the fitness testing. The Air Force has mandated that health and wellness centers be established on all Air Force bases (Friedman, 1996), with the mission of providing a center for exercise and diet programs and employing qualified personnel to conduct the programs and fitness tests. As of 1996, 22 such centers had been established, with a final goal of 77. The Navy has a Health and Physical Readiness Program, although no specific fitness training is provided. Within this service at least, performance of individuals on the Navy PRT has been traced directly to the perceived attitude of the commander (Bourne et al., 1994).

Few systematically collected data are available regarding the numbers of military facilities or commands that provide duty time for physical activity or conduct organized physical activity programs; however, a number of active-duty women who were interviewed acknowledged that the amount of time allowed for physical activity during the duty day varied considerably from one worksite to another and that many, especially those working in health care, were given no time for regular physical activity (Friedman, 1996; Hernandez, 1996; King, 1996). Two self-report surveys of military personnel (Bray et al., 1995; Hourani, 1996) have found that approximately 60 percent of active-duty women report exercising vigorously for 20 or more minutes, 3 or more days per week. Anecdotal reports suggest that many service personnel increase their activity level within a month of their fitness evaluations to ensure retention and then decrease their activity for the subsequent months, which results in a varied fitness (and potentially body weight, health, and readiness) level across the year. No data were available regarding the methods that active-duty women employ to maintain fitness.

Occupation-Related Fitness

Each branch of the military service performs specific and specialized functions in promoting peace and protecting the populace in war. In response to the increasing entry of women into the Armed Forces during the late 1970s, the Government Accounting Office (GAO) in 1976 recommended that the DoD develop physical standards for job performance based on the Department of Labor system of classification. Consequently, each service defined its critical occupational specialties according to a variety of criteria, including upper body strength (light = occasionally lift 20 lb [9 kg], frequently lift 10 lb [5 kg]; medium = occasionally lift 50 lb [23 kg], frequently lift 25 lb [11 kg]; moderately heavy = occasionally lift 80 lb [36 kg], frequently lift 40 lb [18 kg]; heavy = occasionally lift 100 lb [45 kg], frequently lift 50 lb [23 kg]; and very heavy = occasionally lift 100 lb [45 kg], frequently lift in excess of 50 lb [23 kg]; see Table 3-2) and the physical profile serial designated as P-U-L-H-E-S (physical capacity or stamina, use of upper and lower extremities, hearing acuity, normal color vision, and special psychiatric characteristics). Acceptance into and continued participation in these occupational specialties depends on maintenance of a fitness level adequate to perform the tasks described for the MOS.

Attempts to institute job-specific performance tests in the military date back to the Army Air Corps Aviation Psychology Program during World War II (Hogan, 1991). In the 1970s, as MOSs opened to women, the U.S. Army Research Institute of Environmental Medicine (USARIEM) was tasked with developing a battery of performance tests to match the various MOSs, but these tests were never applied. In 1981, the Army Office of the Deputy Chief of Staff for Personnel formed a Women in the Army Policy Review Group, and the Exercise Physiology Division at the U.S. Army Research Institute of Environmental Medicine was again given responsibility for developing and validating a gender-neutral military entrance physical strength capacity test (MEPSCAT). The incremental dynamic lift proved to be the best predictor of performance on a series of job-related (simulated) criterion performance tasks (CPTs) and was selected for implementation pending validation studies. The study that subsequently validated the incremental dynamic lift (Myers et al., 1984) has been criticized, however, for misanalyzing the data and showing a higher correlation between incremental dynamic lift and simulated task performance on the criterion performance tasks than actually exists (GAO, 1996).

In 1993, legislation was passed that permitted women to fill all MOSs that did not involve direct combat and opened many more billets to women. The number of women in each service currently participating in each MOS category is listed in Table 3-2. As a result of this legislation, the GAO was asked to re-examine the question of job-specific performance testing. Each branch of the military performs fitness testing independently, and the Air Force is the only branch that requires new recruits to take a strength test for MOS assignment (the incremental dynamic lift). Although few data have been collected by any of the branches regarding assessment of task performance capability, since 1989 the Army has collected such data for a select number of MOSs. These data show that fewer than 15 percent of women in heavy-lifting MOSs were strength-qualified for their jobs by the end of advanced individual training. This suggests either that they would be unable to perform parts of their jobs, that the jobs were misclassified, or that task adaptation would prevent their inability to lift the required weight from interfering with their performance (Teves et al., 1985). Few Army personnel reveal trouble completing their tasks. In

contrast, a 1994–1995 self-report survey conducted by the U.S. Army Research Institute (ARI) revealed that 21 to 49 percent of personnel reported difficulty at some time in completing physically demanding tasks, although often this difficulty was handled by working around problems and reassigning tasks. The GAO recommended that the services assess whether a significant problem exists in physically demanding occupations and identify solutions. Recommended solutions included establishing valid performance standards to increase job sustainment, utilization of personnel, and safety; providing additional job training; and redesigning tasks (GAO, 1996).

From 1972 to 1980, the Canadian Forces employed a fitness testing procedure that consisted of a 1.5-mi run, with scoring based on the (Cooper) Institute of Aerobic Fitness program. Because of the morbidity and mortality risk associated with attempting to pass the test after inadequate training, a new testing strategy was sought. The program that was developed subsequently, the Canadian Forces Exercise Prescription test (ExPres), includes a preliminary health screen; an evaluation of aerobic and muscular strength and endurance that is based on the Canadian Standardized Test of Fitness (including a submaximal step test, sit-ups, push-ups, and bilateral test of grip strength); an individually tailored rehabilitative exercise program (prescription) based on the results of the evaluation; and ongoing training (Lee et al., 1990). To establish Minimal Physical Fitness Standards that complied with Canadian Human Rights Commission legislation (which mandates that performance standards must be demonstrably related to the requirements of the job), the ExPres test was validated against a battery of five tasks representing various jobs a typical military person would be expected to perform (Stevenson et al., 1992, 1994). While the ExPres is considered a reasonable measure of general physical ability, it is not considered an adequate assessment of task-specific performance, particularly for the infantry and others with occupations that demand high strength; thus, there has been ongoing effort to develop gender-neutral, task-specific performance tests and standards that can be administered with a minimum of equipment and in minimal time (Chahal et al., 1992). This effort has been further intensified as a result of the abolition, in 1992, of body fat standards for Canadian Forces on the grounds that an insufficient relationship could be demonstrated between body fat and physical performance (Personal communication, S. W. Lee, Ottawa, Canada, 1997). A Battle Efficiency Test, now in use for testing of Canadian Army infantry personnel, has been criticized for its failure to measure all necessary components of fitness and for its time-consuming nature (Lee et al., 1995). An indoor standardized obstacle course has been developed but awaits validation (Jette et al., 1990a). In addition, a physical fitness standards study has identified a series of tasks as being representative of the physical requirements of the average Canadian Forces soldier. These tasks include trench-digging, marching, casualty evacuation, and manual material handling (Lee et al., 1995). Additional job-specific fitness maintenance and/or testing programs have been developed for Canadian Forces firefighters and pilots.

The primary objections that have been raised to MOS-specific performance tests are: the large number of tests the military would be required to devise and administer, the frequency with which people are assigned to new MOSs and/or promoted, and the lack of task specificity for any one MOS. Although the Canadian studies sought to develop one test of strength, endurance, and aerobic fitness that would be generalizable to all job requirements, no data were available on the implementation of this test.

Summary

The DoD mandates that all services evaluate the basic physical fitness of their personnel at least yearly. Each service administers its own test; while the Air Force test measures only cardiorespiratory endurance, the others attempt to measure strength and flexibility as well. Studies show that a high percentage of female personnel, particularly those in the youngest age groups, fail the Army physical fitness test. Comparable data were not available for the other services. Although the DoD authorizes provision of duty time for physical activity, only the Army and Marine Corps explicitly provide this time. However, anecdotal evidence suggests that compliance is dependent on the individual command. Few data are available on the fitness habits of active-duty personnel; self-report data show that approximately 60 percent of active-duty women exercise regularly.

The 277 MOSs are classified into five categories based on requirements for lifting strength. At the present time, a test of physical performance ability/strength is conducted on a regular basis only by the Air Force, which uses the incremental dynamic lift test. In response to concerns that a significant percentage of personnel (and a disproportionate number of women) were unable to accomplish their assigned tasks, the GAO performed an analysis and issued a report in 1996 recommending the institution of task-specific performance tests throughout the military as well as reconsideration of the validity and reliability of the incremental dynamic lift test. Also recommended were job redesign and additional strength training. The primary objection to task-specific physical performance tests has been the potentially large number of tests that would be required and the frequency with which personnel change MOSs.

CIVILIAN PERFORMANCE TESTING

Evaluation of prospective or current employees for jobs that require high levels of fitness (endurance, strength, and aerobic capacity) is more completely developed in the civilian sector. In the United States, task analysis and classification of civilian jobs by physical ability dates back to efforts by the Army Air Corps during World War II (Hogan, 1991) to place qualified soldiers into military specialties. Recent increases in the use of physical abilities' testing is believed to result from the influx of women into the workplace, from passage of the Americans with Disabilities Act, and from evidence that lack of physical fitness for a physically demanding job is associated with increased rates of on-the-job injuries (Jackson, 1994).

Theoretical Issues

The development of fitness/performance standards and tests is a two-step process. The first step requires analysis of the tasks of a particular job and the physical requirements required to perform those tasks, with subsequent formulation of a set of performance test items that mimic the individual tasks. The second step requires validating the test by multiple criteria (Hogan, 1991). The legitimacy of pre-employment hiring tests for physically demanding jobs has been upheld in the court system. Validating such tests is imperative, however, because of the potential

impact of physical performance testing on women in the workforce and the possibility that a test will be challenged for failure to comply with the Uniform Guidelines on Employee Selection Procedures of the Equal Employment Opportunity Commission. Appropriate validation methodology has been the subject of ongoing debate (Jackson, 1994).

Civilian performance testing is classified into two types by the nature of the abilities measured. Physical *fitness* tests seek to measure performance on one or a series of tasks that have shown some ability to predict general aerobic fitness or strength. Physical *abilities* tests (also known as job sample tests or task performance tests) seek to measure performance on tasks that simulate actual job-related activities. Performance tests may be administered as a part of a recruitment qualification test only, or they may be administered regularly to current employees. For such tests to be valid, the abilities measured must be demonstrated to be necessary to (and predictive of) the performance of the actual job (Arvey et al., 1992; Hogan, 1991). An additional concern is that when physical abilities tests are administered as qualification (entrance) exams, performance may be more reflective of prior learning than of aptitude. Thus, the population of subjects used to establish cut-off scores must be identified.

Although most performance test validation studies are not published, those that are have been primarily in the areas of firefighting, police work, chemical and steel plant work, coal mining, utility line work, and military jobs (Jackson, 1994). This discussion will focus only on the civilian uniformed services, that is, government law enforcement and firefighting.

Police Force Physical Tests

A preemployment test for police officers (Wilmore and Davis, 1979) measured both fitness and physical abilities, but test performance proved unrelated to actual supervisor-rated job performance (criterion validity). The Metropolitan Ontario Police Department developed a job-specific Police Officers' Physical Abilities Test (POPAT) to screen new recruits (Rhodes and Farenholtz, 1992). Although task performance correlated poorly with fitness test performance, established officers who scored poorly on the Police Officers' Physical Abilities Test also scored poorly on routine tests of fitness, and the test has been demonstrated to have content validity and accepted for screening of new recruits.

A group of municipal, state, and federal law enforcement agencies (compiled from a list of forces represented at a December 1996 symposium on Women in Uniform, forces listed on the Internet, and those in the Washington, D.C. area) were contacted and questioned regarding their body composition, fitness, and performance testing practices (see Appendix E for inquiry letter and response tables). The results (Table E-1) demonstrate that approximately half of these agencies regularly assess body composition, while the majority assess fitness on a regular basis.

Firefighting Services

According to a report cited by Jackson (1994), most major fire departments administer physical ability tests for recruitment (a large percentage of fire departments are small, comprise volunteers, and may not conduct such testing). Several physical abilities test batteries for fire-

fighters have been constructed from task analyses and have been validated and published. Considine and coworkers (1976) published a test panel consisting of fitness and body composition assessments as well as a series of four work-sample tests. The test panel was found to measure the ability to handle body weight, muscle power, and body structure.

A second test, also consisting of fitness and body composition measures as well as work-sample tests, was validated by Davis and coworkers (1982) who found that two independent factors, physical work capacity and a combination of speed and resistance to fatigue, defined the relationship between performance on the fitness tests and performance on the work-sample tests.

More recently, physiological response to firefighting tasks has been measured and used to validate fitness and performance screening protocols against actual firefighting operations. One example is a fitness test and seven-item task performance battery developed by Gledhill and Jamnik (1992) that assesses air utilization during performance of some tasks.

In 1995, the National Fire Protection Association issued a draft entitled "Recommended Practice for Physical Performance and Conditioning Programs" for the comment and approval of its members and other fire service representatives. This set of guidelines for fitness and performance testing and maintenance recommends both physical fitness assessment and performance assessment. According to the document, physical fitness assessment should test aerobic capacity, flexibility, body composition, muscular strength, muscular endurance, and anaerobic power, and results should be used to assign personnel to health-risk intervention programs. Physical performance assessment tasks, according to the document, should be objective, reliable, and valid, and the recommended tasks are defined with extreme specificity. This specificity has been criticized on the grounds that all test tasks are not valid measures of the job of a given firefighter or service (Personal communication, D. Smith, Pike Township, Indiana, 1997). Finally, the document recommends annual testing of candidates as well as current firefighters and recommends at least 3 d/wk of physical conditioning.

As with the police services, municipal and county firefighting services were polled regarding their body composition, fitness, and performance testing policies. Female firefighters comprised 5 to 11 percent of total personnel among the services surveyed (an estimated 4,500–5,000 women are nonvolunteer firefighters nationwide). Results of the survey of fitness assessment policies are shown in Table E-1.

In contrast to the law enforcement groups polled, all firefighting services regularly assessed fitness and body composition. A variety of approaches were used to assess overall fitness and specific task performance. One approach repeatedly described was the inclusion of body composition assessment as one component (criterion) of a composite fitness score.

Summary

The majority of firefighting services and some police forces place major emphasis on fitness and performance testing for recruitment and retention of fit, qualified employees. When body composition was measured, it was most often regarded as one component of fitness or as secondary to fitness and performance in the evaluation of an incumbent employee. The use of performance or physical abilities tests by firefighting services appears to be increasing in preva-

lence; physiologists who develop such tests place strong emphasis on the proper validation of the tests.

BODY COMPOSITION, FITNESS, AND TASK PERFORMANCE

Body Composition and Fitness

Body Fat and Performance

In a 1992 review in *Armed Forces and Society*, Vogel described how the Army's initial (1982) male body fat standards of 20 percent were formulated, based on a subjective estimate of the level of body fat commensurate with a desirable level of aerobic fitness. Preliminary data (Vogel and Friedl, 1992) showed a negative association between body fat (as determined by the Army equation) and 2-mi run time for the youngest age group of men. Another study of Army personnel found virtually no relationship between body fat and run time of men or women (Harman and Frykman, 1992). Cureton (1992) employed an "added weight" model to attempt to determine whether women's additional body fat was responsible for their lower aerobic fitness. In this model, weight was added to the trunkal area of male subjects, but no differences in performance were seen, possibly because no added weight was distributed to the extremities, as would be the case in women.

In a study of women during basic combat training, Westphal and coworkers (1995) examined the relationship among weight-for-height; BMI; total body fat as predicted by all services' circumference equations and dual-energy x-ray absorptiometry; body fat distribution as predicted by waist-hip ratio; performance on the Army PFT; and measures of strength and task performance (torque task performance, machine lift, bench press, military press, and vertical jump). Increasing BMI was associated with increasing performance on strength tasks, decreasing sit-up and running performance on the Army PFT, and no association with performance of push-ups (also part of the Army PFT). Waist-hip ratio greater than 0.81 (which is associated with higher FFM and greater health risks [see Chapter 2 in this report]) was associated with a significantly increased performance on a torque task, a small but not significant increase in performance on other tests of strength, poorer performance of sit-ups and push-ups, but no effect on run time. Women who exceeded their Army weight-for-height limit during BCT demonstrated greater performance on strength tasks than those who were within standard. When these same women were divided into two groups based on whether or not they exceeded their body fat limit (as assessed by the Army circumference equation for women), those who exceeded the body fat limit were stronger than those who did not, but the disparity in performance was not as great as when the division was according to weight-for-height (thus the weight-for-height screen tends to eliminate more strong women than the body fat screen). Use of the Navy and Marine Corps equations produced similar results. Performance on the Army PFT was not compared between those who exceeded their body fat limit and those who did not in this study. Nevertheless, it appears that increased BMI was associated with poorer performance on the Army PFT but greater strength, and that increased body fat was associated with greater strength.

A study by Jette and coworkers (1990b) examined the relationship between BMI and measures of fitness and strength among Canadian Forces personnel (17,098 men and 2,087 women) stratified into five BMI zones (< 20, 20–25, 25–27, 27–30, and > 30). In this population, 50 percent of the men and 25 percent of the women had BMI greater than 25, while 26 percent of the men and 12 percent of the women had BMI greater than 27. The study showed that over the entire range of BMI, predicted $\dot{V}O_2$max decreased as BMI increased for both men and women. Scores on the push-up test were lower for the two highest women's BMI groups (> 27) than for the lower BMI groups, and for the sit-up test, the scores were lower for the three highest BMI groups of women (> 25). In contrast, grip strength tended to increase with BMI. Thus, except for grip strength, fitness test performance decreased with increasing BMI. In this study, BMI was significantly associated with weight-height ratio and waist-hip ratio, all predictors of fatness. Thus, according to this study, increased fatness appears to be associated with poorer performance on fitness tests.

Fat-Free Mass and Performance

The use of current military PFTs as indicators of ability to perform a job, as acknowledged by Vogel and Friedl (1992), Hodgdon (1992), Robertson and Trent (1985) and others presents a problem; it is that the majority of the military's physically demanding MOSs involve occasional to frequent lifting and carrying, also known as manual material handling. Thus the capacity to lift and carry is a significant aspect of military task performance. Although little association has been found between body fat and lifting capacity, numerous military studies have demonstrated a strong association between FFM and lifting capacity (strength) (Beckett and Hodgdon, 1987; Harman and Frykman, 1992; Vogel and Friedl, 1992). A study of recruits in BCT found that women who failed the body fat standard performed better on measures of strength than those who passed. When these same women were stratified into those who exceeded and those who passed the weight-for-height standard (Sharp et al., 1994), the difference was even more pronounced; women who failed the weight-for-height standard performed significantly better on several measures of lifting and carrying than did those who were within the standard. In the study by Westphal and coworkers (1995), increased waist-hip ratio also was found to predict significantly increased strength in a torque performance test but was not a significant factor in other strength measures. The implication of these studies is that, clearly for women, increased weight for height and waist-hip ratio are associated with higher FFM, which is associated with greater strength.

Although strength is recognized as a vital component of military performance and fitness, controversy still exists regarding how to measure this aspect of fitness in a valid way, particularly in a field situation (Vogel and Friedl, 1992). This controversy also exists for civilian tests of task performance. Sit-ups and push-ups are used to measure strength on the Army PFT. Although Army PFT scores for push-ups and sit-ups correlated well with strength and load carriage performance in the study of Westphal et al. (1995), none of the Army PFT tasks correlated well with the power or muscle strength tasks. Westphal and coworkers (1995) and other military researchers (for example, Harman and Frykman, 1992; Sharp et al., 1994) have recommended the use of

job-specific task performance tests for occupational assignment. Vogel and Friedl (1992) have suggested the use of a minimum acceptable FFM standard that would be compatible with the ability to perform the tasks required for many MOSs, in lieu of other standards of body composition.

Musculoskeletal Injury and Fitness

Studies of the role of fitness in job performance cite the contribution of poor physical fitness to an increased incidence of job-related injury and disability. Numerous reports have found that women in Army BCT appear to sustain more musculoskeletal injuries of the lower extremities than do men (Canham et al., 1996; Jones, 1996; Jones et al., 1992, 1993, 1994). Similar observations have been made regarding injuries of the lower extremities and pelvis in Marine Corps personnel (Moore, 1996). Jones and coworkers (Canham et al., 1996; Jones, 1996; Jones et al., 1992, 1993, 1994) have studied men and women in Army BCT for approximately 10 years to assess the factors contributing to injury risk. They found that women tend to have a higher risk of all types of lower-extremity, musculoskeletal injury than do men, including stress fracture of the tibia. Both higher- and lower-than-average BMIs are associated with increased risk for injury, which suggests that the heaviest as well as the lightest soldiers are at greater risk. When men and women of equal fitness level (as measured by run time) are compared, however, the gender differences in injury rate disappear, which suggests that aerobic fitness could be an important factor. Fitness prior to entering BCT is also a factor in injury incidence. Although more studies are needed, particularly those including soldiers after initial training and examining other lifestyle issues (such as diet and smoking), the evidence suggests that fitness plays a role in preventing musculoskeletal injuries in military personnel and that there may be some justification for a minimum FFM standard.

Strategies to Improve Performance on Physically Demanding Military Tasks

The establishment of MOS-specific fitness standards and corresponding physical abilities tests is only one means of ensuring that military personnel are qualified to perform their jobs. Two additional strategies that are under investigation are the optimization of strength training to allow women to reach their full potential and the ergonomic redesign of tasks and equipment to decrease the need for physical exertion.

Strength Training

According to a review of strength training efforts by the Army (Sharp, 1993), the average woman soldier weighs 20 percent less and has 10 percent more body fat and 30 percent less muscle than the average male soldier. As mentioned earlier, lifting and carrying are strongly associated with FFM. Muscle strength can be classified in two ways: isometric strength (no movement) and dynamic strength (isotonic and isokinetic strength). Women soldiers demonstrate 60 to 70 percent of the isometric strength of men. Women's relative lower body strength is

greater than their upper body strength, similar to the female-to-male ratios of upper- and lower-extremity muscle mass. In addition, correction of strength for muscle mass causes most of the gender differences to disappear, suggesting that male and female muscle does not differ that much in its ability to exert force, per se.

When dynamic strength is compared between men and women, women soldiers exhibit 50 percent of men's ability on the incremental dynamic lift but 60 percent of men's ability on a box lift task, which suggests that training plays a role and when the task is familiar, women may be better able to adapt and vary their technique.

Comparison of muscular endurance between women and men reveals that women's endurance is less. They use a greater percentage of their maximum lifting strength for a given task. When expressed relative to body weight and FFM, however, women are more similar to men. Thus, the conclusion is that muscular strength and endurance in women can be increased if FFM is increased.

Strength training can result in increased FFM due to its ability to increase cross-sectional area of muscle fibers. Men and women increase their percentage of muscle mass equally with equivalent training, but the actual absolute increase is greater in men. While BCT increases FFM in men and women, it does not change the female-to-male strength ratio. Increases in isometric strength of 40 to 60 percent would be necessary to achieve parity between women and men. Such an increase would be highly unlikely (increases of 4–16% are reported). In addition, several studies have found that women who possessed higher upper body strength at the beginning of BCT improved far less during the 8-wk period than those with less upper body strength, which suggests that the training might have been less than adequate for these stronger women (Nindl et al., 1995). With *endurance training* also, the greatest improvement occurs in those whose fitness was poor to begin with. Contradictory findings have been obtained regarding whether military training significantly increases the female:male ratio of $\dot{V}O_2max$.

According to Sharp (1993), *occupational training* can eliminate many performance differences between men and women, or among personnel of different abilities. Research on task performance by women has shown that several mechanisms can reduce the physical demand of tasks. These include self-pacing, task redesign (for example, the use of teams to perform heavy lifting tasks), equipment redesign or development, and physical screening and recruitment of women who can physically perform the tasks.

Over the past 5 years, several groups of Army researchers, notably the group at the U.S. Army Research Institute of Environmental Medicine and the U.S. Army Research Laboratory (ARL), Aberdeen, Maryland, have experimented extensively with intensive strength training for women soldiers as a means of increasing their availability to the heavy and very heavy MOSs. In a study conducted by Harman et al. (1996) involving a 28-wk (5 d/wk, 1–1.5 h/d) program that combined strength, endurance, and aerobic training, all women were able to fulfill the lifting requirements of the very heavy MOS by 14 weeks (lifting 100 lb [45 kg] to table height). From pretesting to the end of the program, there was a greater than threefold increase in the percentage of women who could lift this weight to the height of a truckbed (24% to 78%). Army PFT scores improved, body fat decreased, and FFM increased in these women. Knapik and Gerber (1996) at the U.S. Army Research Laboratory reported similar but less dramatic results after a 14-wk training program.

In a 1996 symposium at the annual meeting of the Human Factors and Ergonomics Society, Knapik presented a paper on the use of task-specific versus general training methods to improve manual material handling capability by military and civilian personnel. *Task specific training* uses the same tasks for training and testing, while *general training* uses a variety of tasks for training but a completely different set of tasks for testing. Performance improvement is significantly greater following task-specific training, partly due, apparently, to psychomotor learning.[2] Although gains in strength performance are smaller following general training, the advantage of the latter type of training is that it can be applied to a wide variety of tasks, similar to those faced in a number of MOSs (Knapik, 1996).

Job Redesign

In addition to their efforts in the area of strength training for women, the groups at the U.S. Army Research Institute of Environmental Medicine and U.S. Army Research Laboratory have also been involved in the redesign of five sample Army tasks (dePontbriand and Knapik, 1996). The rationale behind task redesign includes two considerations: (1) increasing numbers of military personnel, including women and some of the North Atlantic Treaty Organization (NATO) troops with whom U.S. forces have joined, are too small to handle much of the equipment and perform many military tasks that were designed to be commandeered by larger U.S. men; and (2) lowering physical demands should decrease job-related injuries, prolong ability to exert strength and increase endurance (increasing performance sustainment and maintenance), and permit more flexible personnel utilization. For example, of the 277 current MOSs, 175 require occasional lifting of 100 lb [45 kg] or more and frequent lifting of 50 lb [23 kg] or more. Approximately 20 percent of military-age males and 80 percent of military-age females are reported to be incapable of performing at this level (Headley and Rice, 1996). If such jobs could be redesigned to decrease the load-bearing requirement, more personnel would be strength-qualified to perform them.

Task redesign involves, first, the collection of all data pertaining to the nature of the tasks, training to perform the tasks, and accident reports associated with the tasks. Then, the tasks requiring the most strength are identified, and films of personnel performing each task according to prescribed methods are analyzed. Redesign options include engineering aids, alterations in packaging, and changes in the operator's physical movements (and possibly the number of personnel) used to execute the task. Observational evidence suggests that when faced with physically challenging tasks, military personnel may redesign the task on their own, using alternative strategies. Stevenson and coworkers (1996) have shown that women's box lift performance was closer to that of men's than scores on the incremental dynamic lift would predict, because women were able to shift the weight of the load when performing the box lift task.

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[2] Psychomotor learning is the acquisition of skill in performing a task as a result of experience believed to result in strengthening of efferent (motor neuron) pathways.

Summary

Performance on military fitness tests does not correlate well with performance on task-specific performance tests or strength tests required for MOSs that demand heavy and moderately heavy lifting and carrying capacities. Performance on strength tests is correlated with higher FFM. Among women in basic combat training, higher body fat has been associated with greater strength, most likely due to the increased FFM of the women. Some studies have found poorer basic fitness test performance among personnel of high body fat and BMI, however.

In addition to performance testing, two strategies have been recommended by military researchers to improve the physical task performance of personnel: occupational strength and endurance training and task redesign. The average military woman has 30 percent lower muscle mass than the average military man. Strength and endurance training can increase muscle mass significantly but not enough to close this gap. Occupational training can be task-specific or general; task-specific training results in greater gains in strength, but the results of general training are applicable to a wider variety of tasks. Job redesign seeks to alter the steps performed or the equipment used to perform a task, maximize safety, minimize energy and manpower utilization, and increase endurance.

CONCLUSION

As outlined, the U.S. military must contend with a dilemma. Optimum physical fitness for readiness and for performance of the more strenuous MOSs requires muscle mass; optimum appearance (defined as looking good in uniform) may require a low body weight, with an accompanying low FFM. The two, however, may not be compatible.

In men, aerobic fitness is related to body fatness and FFM. Clearly, if a mass to be moved increases, the muscular power required to accomplish the move increases. In fact, several studies have shown that in women, $\dot{V}O_2max$ correlates most directly with FFM, not body fat (Cureton, 1992; Harman and Frykman, 1992), and that strength performance is directly related to FFM (Beckett and Hodgdon, 1987; Knapik et al., 1996; Sharp et al., 1994). Thus, the relationship between body composition and fitness in women is clearly one of functional tissue. However, it is body fat that is currently assessed and used as the primary criterion for accession and retention. Thus, in some regard, the body composition standards currently employed by the military may discriminate against the women who would be most capable of performing the jobs requiring strength, those perhaps most critical for survival in a combat situation. Military researchers have recommended the establishment of both a minimum level of FFM commensurate with a minimum level of muscular strength at accession, and task- or strength requirement-specific training and performance testing. Current efforts also include intensive fitness and strength training and task redesign.

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4

Weight Management

According to recent estimates, more than one-third of the adult population in the United States is overweight (Kuczmarski et al., 1994), and the percentage of overweight individuals is increasing. Among those who are not overweight, a significant percentage of adult women are dieting to lose weight. Military personnel differ from the majority of civilian personnel in that while few civilian occupations are permitted by law to require employees to maintain their weight and body fat below an established maximum, military personnel, regardless of their individual occupational specialty, incur increasingly punitive administrative consequences for failing to "make weight." Because of the emphasis placed by the military on meeting standards for body weight and fat, and undoubtedly as a result of the same forces that have driven the increase in weight among civilians, the issue of weight management among military personnel has assumed considerable prominence. Enforcement of the body weight standards has led to the creation of programs for weight loss in each service. This chapter will describe the weight programs of each service, review existing data on the prevalence of weight problems among military personnel and on the outcomes of the weight programs, discuss the ramifications of weight standards in terms of what is known about dieting practices among military personnel, and finally, attempt to measure the current military programs against guidelines that have been established for successful civilian weight management programs.

MILITARY WEIGHT MANAGEMENT PROGRAMS

If U.S. military personnel fail to comply with body composition standards, they are referred to a remedial weight management program. All military weight control program regulations implement Department of Defense (DoD) Directive 1308.1 (1981), which established a weight control program for all services. Each branch of the military has its own weight loss program, based on scientifically and medically accepted approaches for decreasing energy intake and increasing energy expenditure. Personnel participate in these programs until a weight within military standards is achieved.

Army

The Army Weight Control Program is the responsibility of the deputy chief of staff for personnel, with counseling and medical policies established by the surgeon general. Evaluation of weight and appearance, measurement of body fat, and assignment to the weight control program are the responsibility of commanders and supervisors. All personnel are weighed a minimum of every 6 months (at the time of the physical fitness test [PFT]); additional weighings and body fat measures are at the discretion of the commander or supervisor. Personnel who exceed the screening table weight maximum for their height, gender, and age undergo circumferential body fat measurement (see Army body fat standards in Appendix B). Those who exceed body fat standards receive medical evaluation; those found to have no underlying causative disease are entered into the weight control program by the unit commander, and their personnel records are flagged (this notation carries implications for travel, education, permanent change of duty station, and promotion). They must receive nutrition counseling (one visit with a counselor) and are required to meet a weight loss goal of 3 to 8 lb per month (AR 600-9, 1986).

The nutrition counseling component of the Army Weight Control Program is provided by "qualified health care personnel," according to Army Regulation 600-9 (1986). Depending on the availability of such personnel, the counseling may be provided by registered dietitians, dietetic technicians, physicians' assistants, nurses, or physicians. Beyond the initial visit, there is no requirement regarding the number of visits, and an unlimited number of follow-up visits is permitted (Personal communication, LTC J. P. Warber, U.S. Army Research Institute of Environmental Medicine, Natick, Mass., 1997). The educational materials and counseling provided appear to vary from one facility to another (Personal communication, C. Baker-Fulco and LTC J. P. Warber, U.S. Army Research Institute of Environmental Medicine, Natick, Mass.; A. D. Cline, Pennington Biomedical Research Center, Baton Rouge, La., 1997). A general nutrition and weight management guide that emphasizes lower-fat food choices, sample menus, and advice on lifestyle and behavioral modification strategies appears as an appendix to Army Regulation 600-9, and may serve as a reference for Army health care personnel to provide counseling to personnel enrolled in weight control programs.

Progress of personnel in the Weight Control Program is monitored on a monthly basis and evaluated at 6 months. Failure to show satisfactory progress for 2 consecutive months or at the 6-mo point may result in additional medical evaluation and ultimately separation from the Army.

Air Force

The Air Force Weight Management Program is described in Air Force Instruction 40-502 (1994) and implements Air Force Policy Directive 40-5 (1994), "Fitness and Weight Management." The Weight Management Program is the responsibility of each installation commander, with counseling and medical policies established by the deputy chief of staff for personnel, the surgeon general, and the Air Force Nutrition Committee. As in the Army, evaluation of weight and appearance, measurement of body fat, and assignment to the Weight Management Program is the responsibility of commanders and supervisors. All personnel are weighed, without notice, a minimum of every 12 months; additional weighings and body fat measures are at the discretion of the commander or supervisor. Personnel who exceed the screening table weight maximum for their height, gender, and age group or who appear to exceed body fat standards or who fail to present a "professional military appearance" undergo circumferential body fat measurement (see Air Force body fat standards in Appendix B). Those who exceed body fat standards receive medical evaluation; a 6-mo body fat standard adjustment may be made by the Medical Service if the person is deemed to be otherwise physically fit. Those personnel found to have no underlying causative condition or disease receive diet counseling and are entered into Phase I of the two-phase Weight Management Program and a 90-d exercise program by the unit commander. Such personnel are restricted from some travel; in addition, they are ineligible for education, permanent change of duty station, and promotion (AFI 40-502, 1994).

Phase I of the Weight Management Program is administered by the Nutrition Medicine Service, with counseling provided by authorized diet counselors, who are defined as registered dietitians, authorized diet therapists, or other health professionals authorized by the Major Command (MAJCOM) consultant dietitian (AFI 40-104, 1994). While initial and follow-up counseling are specified in Air Force Instruction 40-502 (1994), the actual counseling may be conducted for various lengths of time, including a one-time class, a 4-wk program, or a 16-wk program (a mandatory program of quarterly diet counseling has been discontinued); some of the programs include a fitness component (Personal communication, MAJ J. M. Spahn, Elmendorf AFB, Alaska, 1997). Counseling is based on Air Force Instruction 44-135 (1994), "Clinical Dietetics," which in turn is based on the American Dietetic Association's *Manual of Clinical Dietetics* (Personal communication, MAJ J. M. Spahn, Elmendorf AFB, Alaska, 1997). Class materials are updated quarterly. Counseling sessions or classes cover the content of Air Force Pamphlet 44-132 (1994), "Dietary Information for Weight Loss." This 57-page booklet includes basic instruction on nutrition, physiology, foods and low-fat food choices, sample menus, portion guides, methods to chart progress, behavioral modification strategies, and references. In addition, individuals enrolled in the Weight Management Program receive the booklet Air Force Pamphlet 44-133, "Improving Eating Habits," and Air Force Pamphlet 44-125, "Good Eating: A Dieter's Guide," as well as a food diary and exercise log (AF Form 3529, 1993) to teach self-monitoring of food intake and exercise.

Individuals who complete Phase I of the program are enrolled in Phase II, a 6-mo observation period during which they are weighed monthly. This is followed by a 1-y probationary period, during which personnel can be weighed at any time. Personnel are encouraged at all times to return to the nutrition clinic for individual counseling and quarterly follow-up classes. Those who repeatedly fail to make satisfactory progress (defined as a decrease of at least 1 percent body

fat per month or a weight loss of 3 lb per month for a woman) may be subject to increasingly severe administrative actions, culminating in discharge or separation, as described in Air Force Instruction 40-502 (1994).

Navy and Marine Corps

The Navy Weight Loss Program is described in Naval Operations Instruction 6110.1D (1990), "The Physical Readiness Program." Commanding officers are responsible for providing a conditioning program comprising fitness and nutrition education. The program is administered by certified fitness counselors. Navy and Marine Corps personnel undergo weighing every 6 months in conjunction with the physical readiness test (PRT). Those individuals who exceed the gender- and height-specific weight standards (Navy standards are not age specific) are subject to circumferential measurement. Those whose body fat exceeds the 30 percent standard may be referred to a counseling and assistance center rehabilitation program. Prior to 1995, this program comprised three tiers. Level I consisted of a command-directed, remedial, physical conditioning program lasting approximately 6 months and sometimes incorporating nutrition education and other elements; failure to progress in Level I resulted in assignment to Level II, which consisted of a 2- to 6-wk intense outpatient weight management counseling program. Level III was a 4- to 6-wk inpatient obesity treatment program and required a diagnosis of "compulsive overeating" (not recognized by the *Diagnostic and Statistical Manual of Mental Disorders, 4th edition* [DSM-IV] or Naval Bureau of Medicine) for entry. In 1995, Level III was eliminated, because it was felt that the majority of overweight personnel need education rather than inpatient treatment and because the criterion for entry was not a true diagnosis. In 1996, a 2-wk outpatient weight management program was adopted, focusing on nutrition education and lifestyle behavior changes. The command-directed physical conditioning program consists of mandatory exercise sessions with regular monitoring of the individual's body composition; it is designed to motivate the development of regular exercise habits.

The Navy Weight Loss Program now relies on the "Navy Nutrition and Weight Control Self-Study Guide: Forge the Future" (NAVPERS 15602A, 1996), which was developed to be the principal tool to enable service personnel to improve individual health and fitness. The study guide is used in conjunction with the command's physical conditioning program by every member of the Navy who exceeds body fat standards. The study guide was prepared by Navy personnel, including physicians, nurses, and registered dietitians. This guide provides an overview of nutrition, behavior modification, and exercise and includes recommended readings and references. The weight loss diet is based primarily on decreasing the dietary intake of fat and increasing the dietary intake of fiber from grains, fruits, and vegetables.

Outcome Assessment for Military Weight Management Programs

None of the military nutrition or personnel professionals contacted were able to identify any research to determine the availability of nutritionally trained health care professionals, the uniformity in implementation of weight control programs, or outcomes of these programs at military sites around the world. Data were not available on the numbers of individuals who were

referred to weight control programs. It was agreed by those contacted that enforcement of the weight standards by referring individuals to weight control programs was entirely at the discretion of unit commanders and supervisors and was done on an individual basis.

Regarding outcome analysis, no data were available on the rate of success or recidivism of the weight control programs except for a small study of Navy personnel. Trent and Stevens (1995) compared the 6-wk, 6-mo, and 12-mo outcome of patients enrolled in programs at approximately 20 different command sites and found that although maintenance of weight loss at 12 months was higher than civilian studies have reported, absolute loss was small. Interpretation of the results is complicated by the fact that the study compared personnel enrolled in three program levels. Whereas the most intense Level III (a 6-wk in-patient program) has since been abolished, the current program is most similar to the former Level II program. In addition, attrition was significant, and there was no control group. Nevertheless, based on their results, the authors recommended changing the Navy's approach to treatment of overweight, including adoption of a long-term, supportive, behaviorally based "aftercare" program.

The 1992 Institute of Medicine (IOM) report, *Body Composition and Physical Performance*, recommended examining data compiled by the Army Medical Remedial Enlistment Program database to evaluate long-term health outcome and performance of program participants, as well as to perform a cost-benefit analysis of the program; however, these data were not available. The numbers of active-duty enlisted women separated from service in fiscal year 1996 for failure to adhere to the body composition standards are listed in Table 4-1. The Air Force was the only branch of service that separated female commissioned officers in fiscal year 1996 for failing to adhere to weight standards. Five women were separated, all between 26 and 40 years of age; three were minorities. According to one Air Force dietitian, the DoD is developing a software program to collect outcome data on weight reduction programs (Personal communication, MAJ Joanne M. Spahn, Elmendorf AFB, Alaska, 1997). At present, this software is being tested.

TABLE 4-1 Active-Duty Enlisted Women Separated from U.S. Military Service in Fiscal Year 1996 for Failure to Meet Body Fat Standards

Service Branch	Total Number of Women Separated in FY1996	Separated Personnel as a Percentage of the Active-Duty Force (%)	Percentage of Personnel Separated Who Were 17–25 Years Old (%)	Percentage of Personnel Separated Who Were Minorities (%)
Army	271	0.5	69	46
Air Force	144	0.3	60	26
Navy	419	0.9	58	44
Marine Corps	19	0.2	63	47

SOURCE: Defense Manpower Data Center (Rosslyn, Va., 1997).

Summary

The DoD mandates that the services maintain a weight management or body composition program for personnel who exceed the maximum gender- and age-defined percent body fat established by their service. Each service maintains its own program under the direction of the site commander but administered by authorized health care personnel (the Marine Corps refers personnel to the Navy program). In general, the programs require that personnel undergo a medical exam to rule out a medical cause for overweight, and that they attend a minimum of one meeting with a health professional designated as a nutrition counselor. Program participants are weighed periodically and must demonstrate a minimum weight loss each weighing period until their goal weight or body fat is met. Additional counseling sessions, classes, and remedial physical activity programs are sometimes provided or recommended. Referral to and participation in the weight management programs can result in personnel actions such as denial of travel, permanent change of duty station, further education, and promotion. Except for periodic weigh-ins, there is no mandatory long-term follow-up or ongoing counseling.

The degree of uniformity with which these programs are administered from one site to another within the same service has not been studied, although it is acknowledged that the nutritional expertise of health care personnel varies among locations. In addition, long-term outcome studies have not been performed to determine the success of the overall programs, individual programs, or individual participants. Such studies are now under consideration. It is not possible to use data on numbers of personnel separated from service for failure to comply with body fat standards as an estimate of the success of the weight management programs because separation from service is at the discretion of the command.

PREVALENCE OF ACTUAL AND SELF-PERCEIVED WEIGHT PROBLEMS

Data on the prevalence of overweight and eating problems among military women derive from three sources: (1) large self-report surveys of health status, (2) smaller surveys (self-report, sometimes with accompanying clinical measures) of women in basic combat training (BCT) classes or other training situations, and (3) personnel and medical databases that compile data on the percentages of personnel stratified by body mass index (BMI, weight in kilograms divided by the square of the height in meters), body fat, or weight for height as well as the incidence of separation for failure to meet body composition standards.

Large Self-Report Surveys

Data were requested from the Army, Navy, and Air Force that profiled the weight for height or BMI of all (or a representative sample of) active-duty women. These data are gathered annually or semiannually by each service during the mandatory routine medical exam. Data obtained from the Army *Health Risk Appraisal* database for 1995, the most recent year for which data are currently available, from a sample of 17,400 female soldiers (both active duty and those serving in the reserves) revealed a mean BMI of 22.7 ± 3.29 (SD) (Personal communication,

V. R. Rao, U.S. Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Grounds, Md., 1996) with 13.9 ± 0.1 percent at a BMI of 27.3 or greater (the *Healthy People 2000* [DHHS, 1991] definition of obesity for women age 20 and older). The prevalence of overweight by this definition increased with age, from 3.6 ± 0.1 percent for women under age 21 to 28.4 ± 0.2 percent for women over age 40. The prevalence of overweight was approximately twice as high for reservists as for active-duty women and tended to be higher for Hispanic women than for African American and Caucasian women. Comparable data were not available from the other branches of service.

The 1995 *Survey of Health-Related Behaviors among Military Personnel* (Bray et al., 1995) reported the prevalence of overweight based on calculations of BMI from self-reported height and weight (Table 4-2) and on the definition of overweight used in *Healthy People 2000* (DHHS, 1991), which is a BMI greater than or equal to 25.7 for women under age 20 and a BMI

TABLE 4-2 Prevalence of Overweight among Active-Duty Personnel, by Age and Gender

	Branch of Service				
Gender/Age Group	Army	Navy	Marine Corps	Air Force	Total DoD
Males*					
Under 20	19.3 (1.9)	20.8 (4.1)	23.9 (2.3)	20.2 (3.5)	20.8 (1.5)
20–25	12.8 (0.9)	17.3 (1.2)	8.9 (0.9)	10.3 (0.9)	12.8 (0.6)
26–34	16.7 (1.7)	24.1 (1.5)	11.1 (1.3)	19.2 (1.5)	19.3 (0.8)
35 and older	19.4 (1.6)	29.2 (0.9)	14.0 (1.5)	25.5 (1.5)	23.9 (0.8)
Females†					
Under 20	+ (+)	14.1 (3.7)	+ (+)	+ (+)	10.5 (2.6)
20–25	5.0 (1.6)	9.2 (2.5)	1.1 (0.8)	4.6 (1.1)	5.6 (0.9)
26–34	11.8 (3.2)	12.0 (2.0)	2.7 (1.6)	5.2 (1.1)	9.1 (1.3)
35 and older	14.8 (2.2)	9.7 (2.1)	2.3 (1.4)	10.3 (3.4)	11.4 (1.7)
Total DoD					
Under 20	17.4 (2.1)	19.2 (3.4)	22.8 (2.2)	18.0 (2.5)	19.0 (1.4)
20–25	11.8 (0.9)	16.4 (1.2)	8.6 (0.9)	9.2 (0.8)	11.9 (0.6)
26–34	16.0 (1.7)	22.9 (1.3)	10.7 (1.2)	17.2 (1.4)	18.1 (0.8)
35 and older	18.8 (1.5)	27.5 (1.0)	13.6 (1.4)	23.5 (1.5)	22.6 (0.8)

NOTE: Table entries are percentages of personnel meeting criteria for being overweight (with standard errors in parentheses). Overweight was defined in terms of body mass index (BMI), where BMI = (weight in kilograms) ÷ (height in meters).[2] Estimates have not been adjusted for sociodemographic differences among services. +, low precision. DoD, Department of Defense.

* Defined as being overweight if BMI ≥ 25.8 for men under age 20 or BMI ≥ 27.8 for men aged 20 or older.
† Defined as being overweight if BMI ≥ 25.7 for women under age 20 or BMI ≥ 27.3 for women aged 20 or older.

SOURCE: *Survey of Health-Related Behaviors among Military Personnel* (Bray et al., 1995).

greater than or equal to 27.3 for women aged 20 or older. By this definition, 10.5 percent of military women under 20 years of age, 5.6 percent of military women 20 to 25 years of age, 9.1 percent of military women 26 to 34 years of age, and 11.4 percent of military women 35 years of age or older were overweight. Although these percentages for military women are well below the 15 percent goal recommended by *Healthy People 2000*, it is not possible to ascertain from them the proportion of active-duty women who exceed the weight standards at any one time because the current maximum weight-for-height standards correspond to BMIs of 25 or less, depending on service and age (see Table S-3 in Executive Summary).

A recently completed survey of active-duty Army personnel by Warber and coworkers (in preparation) found that of 494 female respondents, 25.1 percent had a BMI of 25 or higher, while 2.4 percent had a BMI of 30 or higher (compared with 57.6% and 5.8% of men, respectively). Thus, 74.9 percent of women and 42.3 percent of men had a BMI less than 25. Nevertheless, an average of 59.3 percent of women reported that they were trying to lose weight (54% of women 29 years of age and younger, 64% of women 30–39 years of age, and 73% of women 40 years and over), compared with 37.4 percent of all men.

The 1995 *Sample Survey of Military Personnel*, a cross-sectional survey of active-duty Army personnel, found that among 7,376 female respondents, 9 percent reported exceeding the Army's age-dependent body fat standards (30–36% body fat), although 20 to 28 percent reported difficulty meeting the weight standards (Verdugo, 1996).

A self-report survey administered to 9,859 Navy and Marine Corps personnel (*Perceptions of Wellness and Readiness Assessment*, POWR'95, as reported by Graham, 1996 and Hourani, 1996) found that in response to the question "Do you consider yourself overweight?", 46 percent of Navy women and 31 percent of Marine Corps women reported they did consider themselves overweight; these percentages are considerably higher than the actual percentages of Navy and Marine Corps women who are overweight by published standards. Minority women reported a failure to meet the standards more often than Caucasians.

Smaller Surveys

A study by Rose and coworkers (1993) that examined methods of weight management by military personnel (both men and women) reported that 16.6 percent of soldiers were overweight by Army standards, although only 2.8 percent had participated in the Army Weight Control Program. In contrast to these data, the pamphlet "I Am the American Soldier" (issued by the Fort Benjamin Harrison Soldier Support Center in 1986 and cited by Rose et al., 1993) reported that between 21.1 and 34.5 percent of female soldiers exceed the maximum allowable weight and body fat standards. Of the soldiers in the Rose et al. study, 13.6 percent reported having attempted to lose weight beginning before the age of 18, which suggests lifelong weight concerns, and 85.9 percent of the soldiers were overweight according to their own personal standards. Approximately 66 percent of the soldiers reported having gained weight since accession. The data from the survey by Rose and coworkers indicate that a significant number of female soldiers who responded to the questionnaire had difficulty meeting the Army weight standards. Unfortunately, the response rate for this survey was low, only 26 percent (of a sample of approximately 4,000).

In a study of women in Army BCT, Westphal and coworkers (1995) found that over 25 percent of new recruits exceeded the body fat standards, which suggests that a significant percentage of military women may enter the military with weight problems.

Several studies have reported on the prevalence of overweight and weight concerns at the military academies. A study of U.S. Military Academy, West Point cadets by Friedl et al. (1990) conducted in 1990 found that 14 percent of female cadets were overfat according to Army standards (AR 600-9, 1986); however, by the Cadet Weight Management Program standards of the time, half of the women were classified as overfat. The study showed that 80 percent of female cadets were attempting to lose weight; no correlation was observed between attempting to lose weight and actual body fat level. The U.S. Military Academy has since incorporated the body composition standards of Army Regulation 600-9 (1986). A survey conducted in May 1995 at the U.S. Naval Academy (Drake, 1996) found that although the women had, on average, the same percent body fat and weight for height as their civilian college counterparts, 10 percent exhibited symptoms of disordered eating,[1] according to their scores on the *Eating Disorders Inventory* (EDI, Garner and Olmstead, 1991).

Finally, a self-report survey of Army Reserve soldiers (Sweeney and Bonnabeau, 1990) indicated that 38.5 percent of the respondents experienced difficulty with weight maintenance. Of these, almost half reported never having been in the weight control program, while the rest had been enrolled in the program at least once. The data were not stratified by gender.

Data from Medical and Personnel Databases

Data on BMI and on the prevalence of overweight (by military standards) for the entire military have not been reported. Although the numbers of active-duty enlisted personnel separated from service in fiscal year 1996 due to failure to comply with body composition standards appear in Table 4-1, these data are not indicative of the incidence of overweight in the military because, as described above, the decision to refer a soldier to the weight control program and to pursue separation is made on an individual basis.

Low Body Weight

Currently, the military maintains minimum weights-for-height for recruitment and retention, which for the Army correspond to a BMI of approximately 18.8 for women of short stature but to a BMI of 16.9 for a woman 70 in (1.8 m) in height. Although data on the prevalence of low body weight were not included in the published report (Bray et al., 1995) of the *Survey of Health-Related Behaviors among Military Personnel*, the prevalence rates for BMI less than 19 were obtained from the data set. Based on self-reported weights and heights, the prevalence rates

[1] *Disordered eating* is a term used by the Women's Task Force of the American College of Sports Medicine in its position stand on the female athlete triad (ACSM, 1997) to refer to "a wide spectrum of harmful and often ineffective eating behaviors used in attempts to lose weight or achieve a lean appearance. The spectrum of behaviors ranges in severity from restricting food intake, to bingeing and purging, to the DSM-IV defined disorders of anorexia nervosa and bulimia nervosa" (p. i).

for BMI less than 19.0 were 4.8 ± 0.9 percent (SEM) for Army women, 3.6 ± 0.4 percent for Navy women, 6.8 ± 0.7 percent for Marine Corps women, 4.7 ± 0.4 percent for Air Force women, and 4.7 ± 0.4 percent for all active-duty women (prevalence rates for BMI less than 19.8, stratified by service, age, ethnicity, and rank, are reported in Table 6-4). The highest prevalence of low BMI is observed among Marine Corps women, women less than 20 years of age, Hispanic women, and officers. The recently completed *Army Food and Nutrition Survey* (Warber et al., in preparation) also did not estimate the prevalence of underweight (low BMI); however, when asked whether they were trying to gain weight, 2.8 percent of female respondents reported that they were trying to gain weight (4.6% of women 29 years and younger, and 0.7% of women 30–39 years of age). No data were available on the prevalence of low body fat among active-duty women, as body fat assessments would be performed only on individuals who exceed the maximum weight for their height. According to NHANES III data, the percent of civilian women with BMI less than 18.5 is 5.6 percent of women 20 to 29 years of age, 3.8 percent of women 30 to 39 years of age, 3.0 percent of women 40 to 49 years of age, and 2.4 to 2.5 percent of women 50 to 79 years of age; the prevalence of underweight is higher among Caucasian women than among African American and Mexican American women in the sample population (Personal communication, A. Looker, National Center for Health Statistics, Hyattsville, Md., 1997). As suggested by data from the two military surveys and NHANES III, the prevalence of low BMI is more significant among younger women. Nevertheless, military dietitians and other personnel contacted were unaware of any formal program or intervention to rehabilitate underweight or underfat personnel. A study of women in BCT found that those whose body fat was below 25 percent at enlistment tended to gain weight, body fat, and fat-free mass throughout the 8-wk program (in contrast, women who entered BCT with greater than 25% body fat tended to lose body fat, and those who entered at greater than 35% body fat tended to lose both fat and weight). No follow-up data were available on these women.

Summary

Data on the prevalence of overweight among military personnel are difficult to obtain. Central medical and personnel databases do not appear to contain information that would permit a determination of the incidence of personnel exceeding the body fat standards. Data from two large self-report surveys that use self-reported height and weight to calculate BMI suggest that the prevalence of overweight among active-duty women is comparable to or less than that of a similar population of civilian women; however, these surveys use the definition of overweight established by the *Healthy People 2000* report, which is significantly higher than the age- and service-specific cut-offs used by the military. Thus, it is not possible to estimate from these data the percent of women who are out of compliance with the standard to which they are required to adhere, but it is clear that this figure is higher than the percent defined as overweight by *Health People 2000* standards. Data from several surveys demonstrate that the percentage of active duty women who are dieting and/or dissatisfied with their weight is significantly higher than the percent of women who are actually overweight, suggesting that many women who are not overweight are trying to lose weight. As will be discussed below and in Chapter 5, this has serious implications for health, fitness, and performance.

ISSUES IN WEIGHT MANAGEMENT

Body Image and Weight Maintenance

Evidence suggests that the percentage of active-duty women who perceive themselves to be overweight exceeds considerably the percentage who actually are overweight. The emphasis that is placed on meeting the body composition and appearance standards may contribute to this attitude and to the various means that are used to lose and maintain weight.

Research has shown that women who perceive themselves to be fat are more likely to be dieting and to express weight dissatisfaction (Striegel-Moore et al., 1986). Davis and coworkers (1993a) reported that BMI, but not percent body fat, is significantly correlated with tendency to practice dietary restraint, which suggests that some anatomical factor other than fatness, *per se*, influences the tendency to diet. Subsequently, this group showed that among a population of normal to slightly overweight college women, frame size (as determined by several measures of skeletal structure) was a stronger predictor of weight dissatisfaction and dietary restraint than either BMI or body fat (Davis et al., 1993b). The implication of this finding is that a factor that is both unrelated to actual fatness and resistant to change by diet or exercise is the one most likely to drive the pursuit of thinness and unhealthy dieting. The implication for the military is that women with larger frame sizes and greater muscle, that is, those best suited to lifting and carrying tasks, may be the ones most likely to engage in unhealthy or unnecessary dieting.

In the United States, obesity is increasing among the civilian population (Kuczmarski et al., 1994), with approximately one out of three Americans considered obese as defined by BMI greater than 25. However, there is a segment of the U.S. population whose focus on weight maintenance and ideal body weight results in an increased desire to minimize body weight. This focus is especially typical in women with inaccurate or negative body image, for whom the combination of internal and external pressure may lead to aberrant food intake or disordered eating (Rodin, 1993). Of concern in this group are those who are close to normal weight, for whom dieting can become pathological (Brownell and Rodin, 1994).

Methods Used by Military Women to Lose and Maintain Weight

The primary aim of the study by Rose and coworkers (1993) was to examine the techniques that soldiers use to lose weight following the enforcement of weight standards in the Army. Factors that motivated attempts at weight loss included appearance (42.8%), health concerns (32.6%), and upcoming weigh-in (20.9%). Diet and exercise were the primary methods used to meet the weight standards, but some soldiers used drugs (6.2%), saunas (5.2%), and bingeing-purging (behaviors that could be classified as bulimia) (2.7%). As mentioned above, fewer than 10 percent of the respondents were actually enrolled in the weight control program. Of those soldiers who attempted to lose weight, more than a fourth reported never reaching their ideal weight. The soldiers who reported reaching ideal body weight did so two, three, and four or more times, with 18 percent regaining the lost weight more than four times. The maximum length of time that these soldiers reported maintaining the lower body weight was 3 months or less.

A survey conducted in May 1995 at the U.S. Naval Academy found that 9.6 percent of female and 2.8 percent of male midshipmen reported symptoms associated with disordered eating behaviors. This prevalence rate is less than for civilian college students (Holmes and Armstrong, 1995).

A survey questionnaire administered to an Army Reserve unit (Sweeney and Bonnabeau, 1990) indicated that while 83 percent were within the weight standards, half of these soldiers wanted to lose weight, and 38.5 percent of all respondents reported difficulty with maintaining their weight. Almost half of these soldiers reported never having been on the Weight Control Program, while the rest had been placed in the Weight Control Program at least once. The reservists who were required to lose weight reported using multiple approaches to dieting including: low calorie diet (41.7%), popular diets (26.5%), self-induced vomiting (4.5%), taking laxatives (12.3%), taking diuretics (19.6%), and taking prescription and nonprescription diet pills (26%). The authors reported the frequency of "negative" behaviors in achieving weight loss: the percentage of reservists who used these negative behaviors twice per year, two to five times per year, and more than five times per year were 32.2, 40.7, and 27.1 percent, respectively. Unfortunately, these responses were not reported by gender, and the response rate for the survey was only 51 percent. These frequencies may suggest, however, that the concern for meeting the standards twice a year motivates negative behaviors throughout the year.

As described in a clinical case report (Niezgoda et al., 1989), the use of diuretics by one male and one female soldier preparing for weigh-in caused fainting and nausea of sufficient severity to require admission to an emergency room. While this study is limited by its extremely small size, it indicates the need for further monitoring of weight loss practices within the military.

A recent study quantitated the incidence of bulimic weight-loss behaviors in Air Force weight loss programs and compared the incidence with that in civilian programs. Using a modified version of the *Stanford Eating Disorders Questionnaire* (Agras, 1987), the investigators (Peterson et al., 1995) found that the military weight-management participants indicated a two to five times greater frequency of bulimic behaviors than did the civilian groups.

Finally, a survey study by McNulty (1997) (with a response rate of 53%) to determine the prevalence of eating disorders among active-duty Navy nurses and to identify predisposing factors reported a prevalence of anorexia nervosa of 1.1 percent (similar to that in the female population), a prevalence of bulimia of 12.5 percent (six times that reported in the civilian literature according to a personal communication between the author and K. Vitousek), and a prevalence of eating disorders "not otherwise specified" (DSM-IV, 1994) of 36 percent (compared to 3–35% in the civilian literature according to DSM-IIIR, 1987). The percentage of respondents who reported practicing normal dieting behaviors was 50.4 percent, while the other half reported using one or more of what would be considered aberrant dieting behaviors. Factors associated with the onset of an eating disorder episode included body fat measurement, work stress, change of work schedule, and personal/professional motivation; rank and age were not factors (McNulty, 1997).

The low response rate for military surveys of dieting practices is likely to be the result of a recently rescinded policy that specified the diagnosis of an eating disorder as cause for separation from military service, according to several speakers at the 1996 workshop. As a result, any attempts to estimate the prevalence of eating disorders in the military are likely to underestimate the problem, and studies suggest that the prevalence of subclinical forms of chronic disordered

eating is likely to be even greater that that of full-blown eating disorders. Thus, it is not possible to assess the impact of disordered eating on military readiness.

Negative Diet Behaviors in Civilian Populations

The civilian literature is full of studies of the prevalence of body weight dissatisfaction and disordered eating among young adults. For example, Kurth and coworkers (1995) reported that among randomly selected female college freshmen, respondents to the *Dieting and Bingeing Severity Scale* (DBSS, see Kurth et al., 1995) (N = 1,367), 9 percent could be classified as non-dieters, 26 percent as casual dieters, 23 percent as moderate dieters, 21 percent as intense dieters, 19 percent as dieters at risk, and 2 percent as probably fitting the profile for bulimia nervosa. The authors suggested that their survey instrument can be used in other populations to identify risk factors associated with eating disorders.

Using data from the 1992 *Weight Loss Practices Survey*, Biener and Heaton (1995) found that 47 percent of Caucasian women, 25 percent of African American women, and 16 percent of men who reported to be trying to lose weight had BMIs less than 25. Negative dieting behaviors (fasting, purging, using laxatives, diuretics, or diet pills) were reported by more than 13 percent of the dieters; African American women were more than twice as likely as Caucasian women to engage in such practices (Biener and Heaton, 1995).

In a large survey of 16,486 university students with a mean age of 20.5 years in 21 European countries, only 8 percent of these students were overweight (based on BMI), and fewer than 1 percent were obese (Bellisle et al., 1995). In spite of this, 44 percent of the women were trying to lose weight and 14 percent were actively dieting, which demonstrates that the problem is not limited to the United States. The authors reported that dieting affected snack and meal patterns with twice as many dieters skipping breakfast as nondieters.

Physical Consequences of Chronic Dieting

Body weight variability throughout life is inevitable and can be divided into long-term and short-term changes in body weight. Weight cycling is defined as repeated weight loss followed by regain (Lissner et al., 1991). By far the majority of research that has examined the physical consequences of dieting has focused on two phenomena: (1) the syndrome known as the female athlete triad, the result of chronic energy deficit, and (2) weight cycling. The female athlete triad will be discussed in a later section.

Weight Cycling and Body Composition

Prentice et al. (1992) published a review of the effect of weight cycling on body composition. They addressed the popular view that during energy restriction, energy is mobilized and weight loss is from both the fat and lean compartments, while weight regain is primarily fat. Their review of data from small animal and human weight cycling studies in Great Britain and Gambia found no long-term effect of weight cycling on lean body mass. In British women who underwent a weight loss and regain, lean body mass loss and regain were entirely predictable

from theoretical considerations (Forbes, 1987; Prentice et al., 1991). Prentice and colleagues (1992) concluded emphatically that weight cycling is not associated with negative effects on body composition.

Weight Cycling and Resting Energy Expenditure

In contrast to the popular belief that continued loss and gain of weight lowers resting energy expenditure, Saris (1989) and Wadden et al. (1992) reported no effect of weight cycling on resting energy expenditure.

Weight Cycling and Risk for Disease

Epidemiological studies provide the best evidence for the effect of weight cycling on overall health (Hamm et al., 1989; Lissner et al., 1989; Stevens and Lissner, 1990) In a study of Western Electric employees, one cycle of weight loss and regain in men was a risk factor for cardiovascular disease. In the Goethenburg study, body weight variability at three points in time was an increased risk factor for cardiovascular disease and for overall mortality in Swedish men and women. In the Dutch population described by the *Zutphen Study*, cardiovascular disease risk increased in those persons who had a high BMI and high variability in weight change during 10 years (cited as personal communication in Saris, 1989) .

More recently, the National Task Force on the Prevention and Treatment of Obesity (1994) reviewed the literature on weight cycling and found insufficient evidence to conclude that there was any adverse effect of weight cycling on body composition, energy expenditure, risk factors for cardiovascular disease, or the effectiveness of subsequent attempts to lose weight.

Methods for Successful Weight Management

Although a comprehensive review of the literature on methods for weight loss and management is beyond the scope of this report, several recent reports have reviewed and evaluated these methods (IOM, 1995; Levy and Heaton, 1993; NIH Technology Assessment Conference Panel, 1993). A summary is provided here of the pertinent points from the IOM report, *Weighing the Options* (1995) and the NIH Technology Assessment Conference Panel on methods for voluntary weight loss and control (1993).

In the IOM report (1995), the purpose of which was to propose criteria for the evaluation of dieting programs, programs were divided into three categories: (1) do-it-yourself programs (any individual effort, including participation in a worksite program or support group, sometimes using advice from books or magazines), (2) nonclinical programs (often these are commercial programs that rely on trainers of varying skills and educational background), and (3) clinical programs.

Five broad approaches to treatment were identified. These are diet (modifications with or without nutrition education), physical activity, behavioral modification, drug therapy, and gastric surgery. Except for procedures such as drug therapy and gastric surgery that are obviously lim-

ited to a clinical setting, the actual methods used to achieve weight loss may not differ from one category of program to another.

Although the evaluation criteria were established for the purpose of evaluating programs or products that make claims regarding their success rates, these criteria can be applied to any program, including self-designed ones. The definition of success that was applied took into account recent evidence suggesting that the loss of small amounts of weight can reduce the risk for some chronic diseases and that weight management—that is, long-term *maintenance* of weight loss—rather than the weight loss itself, is the more important factor in reducing risk (USDA/DHHS, 1995).

Three criteria were established by which all weight management programs can be evaluated. The first criterion is how well the program matches the needs of the individual. An extreme example of a poor match would be the prescription of gastric surgery for an individual with 10 lb to lose; a more typical and frequent example of a poor match is the provision of a rigid menu plan without assessment of the individual's health risks, lifestyle, dietary preferences, and nutrition knowledge and without ongoing or at least follow-up counseling.

The second criterion is the soundness and safety of the program. An established weight management program performs a health evaluation that includes an assessment of readiness (Brownell, 1990) prior to formulating a plan with the individual. Do-it-yourself dieters with more than 5 to 10 lb to lose are advised by the media to obtain a medical evaluation before undertaking a diet or exercise program.

Weight management programs are expected to employ staff trained in nutrition and dietetics to provide assessment of current dietary habits, instruction, and counseling. In addition, quality programs must emphasize fitness, evaluate the individual's current fitness level, and employ or refer to trained coaches for development of a fitness plan.

The third criterion of a weight management plan is its outcome, that is the percentage of individuals who have been enrolled in or followed the plan and have maintained their weight loss long-term, had an improvement in their risk factors for chronic disease, and been monitored for any adverse consequences.

Factors Associated with Successful Weight Management

The low rate of success for participants in established weight management plans is well known. Because of this high recidivism, it has been difficult to use the experience of these participants to identify factors that predict successful weight management. Among the possible reasons for the high failure rate of weight management programs are that participants have often tried and failed repeatedly to lose weight on their own and are less predisposed to lose and maintain weight. Similarly, individuals drawn to such programs often have very large amounts of weight to lose (and thus large losses to maintain after years of practicing habits that led to weight gain). While it is known that many individuals lose weight on their own and successfully maintain the losses, until recently, few studies have attempted to document their success rates or strategies. Among the positive predictors cited have been self-monitoring, exercise, positive coping style, continuing contact with a counselor or other health monitor (sometimes referred to as a maintenance program), normalization of eating, and reduction of other comorbidities (Foreyt and Goodrick, 1994; Perri et al., 1992).

Most of the recommendations in the *Weighing the Options* report (IOM, 1995) pertained to the need for additional research in the prevention, etiology, treatment, and long-term implications of obesity. However, one recommendation pertained to program planning, stating that a successful weight management program must include self-monitoring, goal setting, exercise, nutrition education, stress management, and social support. Implied in this recommendation is the idea that weight management is an ongoing process.

The NIH Technology Assessment Conference Panel on methods for voluntary weight loss and control (1993) discussed the risks and benefits of various methods of weight management including dieting, exercise, behavior modification (which consists of identifying eating or related life-style behaviors to be modified, setting specific behavioral goals, modifying underlying precipitants of the behavior to be changed, and reinforcing the desired behavior), drug treatment, and combination therapies. Evidence suggests that the combination of changes in diet and exercise habits with behavior modification to reinforce those changes apparently extends the interval between weight loss and regain. Attributes of successful programs include a plan that results in slow, steady weight loss; development of an eating and exercise plan that can be maintained long term; education in emotional and social stress management and problem-solving strategies; self-monitoring; and maintaining contact with a health care professional. Thus, the emphasis of the NIH Technology Assessment Conference Panel statement is also on the need for a maintenance program.

Prevention of Obesity

In a recent review of obesity prevention research, Wing (1996) outlined times during the life span when a woman is at risk for weight gain. These include young adulthood (20–40 years), pregnancy, and the perimenopausal period (42–52 years). She suggested that it is at these critical times when preventive intervention would have the greatest effect. The vast majority of active-duty women fall into one of these categories.

Weight gain prevention programs, although not widespread, tend to focus on populations or individuals at high risk for becoming obese or for developing obesity-related illnesses. For example, the *Stanford Five-City Study* (Taylor et al., 1991) conducted mass media campaigns and community organization interventions over a 6-y period to lower cardiovascular risk. Subjects in the two experimental cities gained only slightly less weight over time (+0.57 kg vs. 1.25 kg) than did the control cities, so effect on body weight was minimal. Wing (1996) also cites a similar study conducted in Minnesota to reduce the risk of coronary heart disease (Jeffery, 1995). Community outreach, worksite, and home (correspondence) prevention courses, as well as programs focusing on people who were already overweight in six communities over a 6-y period of time were unsuccessful in achieving a sustainable weight loss in the populations of these communities. Because these studies relied on education as the primary prevention intervention, the results indicate that education alone may not be sufficient.

According to *Weighing the Options* (IOM, 1995), prevention programs that target certain high-risk groups with specific interventions (for example, working with families with overweight parents to build regular physical activity into their lifestyles) appear to have the highest record of success, at least in the short term. Because of the need to evaluate the outcome of such efforts in

terms of long-term weight management, however, longitudinal studies must be conducted before their real success can be evaluated.

Summary

Research among civilian women has shown that women who perceive themselves as overweight are more likely to be dieting. Frame size is a stronger predictor of weight dissatisfaction and eating restraint than body fat or BMI, a finding of significance to the military population. It is difficult at this time to ascertain the methods used by active-duty women to lose weight or the prevalence of disordered eating among this group. Several small surveys that have attempted to assess the percentage of active-duty personnel who have engaged in disordered eating behaviors or other unhealthy weight management behaviors (such as use of diet pills, laxatives, and diuretics; purging; or excessive exercise) have reported incidences both similar to and significantly higher than those among comparable civilian populations. A potential health risk of chronic dieting is weight cycling. The prevalence of weight cycling, that is, repeated weight loss and regain, appears high among active-duty women. Although no convincing evidence has been found to support an association between weight cycling and risk for chronic disease, immediate effects of chronic dieting on readiness cannot be dismissed (see Chapter 5).

Several national panels have examined existing civilian weight management strategies and established guidelines for successful weight loss and management programs. Programs were evaluated for how well they matched the needs of the individual, soundness and safety, and outcome. The long-term success of weight loss programs is notoriously poor. Nevertheless, factors found to be associated with positive outcome were self-monitoring, exercise, development of a positive coping style, and continuing contact with a counselor or other health monitor. The importance of a long-term approach to weight management is supported by civilian research, although data examining long-term maintenance programs in the military are extremely limited. A growing body of data supports the effectiveness of worksite weight management programs, which may provide a model for military programs. Finally, weight gain prevention efforts that target specific high-risk groups and employ specific interventions appear to have achieved some success among families.

CONCLUDING REMARKS: WEIGHT MANAGEMENT AS A MILITARY READINESS ISSUE

Herrold (1996) defined readiness for a mission as maximizing performance, minimizing unplanned losses, and adapting to changing environments. Military personnel must be dependable, trained, healthy, physically fit, and well equipped. The weight management component of readiness includes a focus on the body as a tool for readiness. Therefore, one must maintain the tool in optimum condition. This type of maintenance approach includes preventing weight gain in those who currently meet the standards, administering an effective weight loss program based on current research, and implementing an exemplary weight maintenance program. Increased emphasis on maintaining fitness and the fitness program at all stages of a military career supports weight maintenance and decreases the need for efforts aimed at weight loss.

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5

Nutritional Concerns of Military Women

The Military Recommended Dietary Allowances (MRDAs) (AR 40-25, 1985), based on the 1980 edition of the Recommended Dietary Allowances (RDAs) (NRC, 1980), dictate the nutrient content and density of operational (field) rations and military dining hall menus. Recent attempts to revise the MRDAs were considered in a 1995 letter report by the Committee on Military Nutrition Research (CMNR) (IOM, 1995a). The MRDAs, like the RDAs, feature nutrition allowances designated specifically for women, but unlike the RDAs, these allowances are not age specific. Because the RDAs themselves also are currently under revision, the Committee on Body Composition, Nutrition, and Health (BCNH committee) believed that it was beyond the scope of this report and its collective expertise to evaluate the adequacy of the MRDAs for active-duty women at this time. Instead, this chapter focuses on several nutritional issues deemed by the committee to be of particular concern for active-duty women.

CONSEQUENCES OF CHRONIC DIETING

In the previous chapter, evidence was presented that suggests a high percentage of active-duty military women chronically or repeatedly engage in dieting practices that may put their health at risk. The long-term health consequences of one aspect of this chronic food restriction,

weight cycling, were discussed and appear to be insignificant. In this section, several major health implications of chronic restrictive dieting are described.

Energy Deficit and Cognitive Function

Military readiness may be affected by chronic energy deficit. The original studies of semi-starvation by Keys et al. (1950) demonstrated that long-term food restriction is associated with reduced heart rate, lethargy, depression, and irritability. While the subjects in these studies complained of changes in intellectual functions such as concentration, judgment, and memory, the testing protocol used in these studies did not demonstrate a serious impairment. More recent research has focused on the impact of chronic dieting on cognitive functions.

Chronic dieting may have a negative impact on cognitive functions, such as attention, vigilance, and reaction time, that may be important in a military setting. For example, evidence suggests that restrained eating (that is, conscious control of eating in relation to concerns about weight) may result in preoccupation with food and eating, binge eating once food is available, and increased emotional responsiveness (Polivy, 1996). Chronic dieters may be more distractible than nondieters and are less able to concentrate on rote tasks in the face of noise or other environmental distractions (Polivy, 1996); they may also display poorer vigilance, poorer immediate memory, and have slower reaction times (Green and Rogers, 1995; Green et al., 1994; Kretsch et al., 1997). Short-term dieting has been reported to decrease plasma tryptophan and brain serotonin function (as indicated by an increase in tryptophan-stimulated prolactin secretion) and to increase irritability and sleep disturbance in women (Anderson et al., 1990; Goodwin et al., 1987a, b).

Studies on the psychological effects of chronic dieting have produced mixed results. For example, some studies have reported depression, anxiety, decreased self-esteem, and other negative psychological outcomes among dieters (Brownell and Rodin, 1994; French and Jeffery, 1994; Polivy, 1996). However, other studies have reported positive psychological findings, such as improved mood and decreased depression (French and Jeffery, 1994). The positive findings may be associated with use of behavior therapy when dieting, which may counteract some of the negative psychological impacts of chronic dieting (French and Jeffery, 1994). As mentioned previously, dieting behavior may also be a risk factor for the development of eating disorders, but its causal strength is unclear (French and Jeffery, 1994).

Female Athlete Triad

Chronic restrictive dieting and high levels of exercise have been associated with amenorrhea and a related increase in the risk of osteoporosis and stress fracture of the lower extremities and pelvis in a syndrome known as the female athlete triad (ACSM, 1997; Bennell et al., 1995).

A considerable amount of research has been devoted to pinpointing the nutritional factor(s) responsible for, as well as the mechanisms involved in, female athlete triad. In a review that focused on women who participate in competitive athletics, the frequency of stress fractures was reported to be four times higher in women who report irregular menses than in eumenorrheic

women (Lloyd, 1993). Several questions must be answered with regard to the female athlete triad. These include how diet and or exercise contribute to menstrual status, and whether it is menstrual status alone or in combination with nutritional status that increases the risk for osteoporosis and stress fracture. In the review by Lloyd, menstrual history is shown to be an independent risk factor for musculoskeletal injury. Considerable research has sought to elucidate the factors that contribute to amenorrhea in the athlete.

Energy Intake

The question of whether reduced energy intake or negative energy balance is responsible for the hormonal imbalance associated with the female athlete triad has been investigated using models of self-imposed energy restriction (dieting), eating restraint, and controlled studies of energy intake and expenditure.

The effect of a brief period of imposed energy restriction on sex hormone and menstrual status was examined by Kurzer and Calloway (1986). Following 1 month on a diet containing recommended levels of all nutrients and providing 40 kcal/kg body weight (during which time weight remained constant), the energy intake of six normal weight women was decreased by 59 percent (with intake of all other nutrients remaining adequate) for 1 month. During the latter period, weight loss ranged from 7 to 15 lb (3.2 to 6.7 kg), and the two leanest women (who also lost the most weight) became anovulatory and amenorrheic.

Rock and coworkers studied 76 college women (BMI 19–25), none of whom had ever been diagnosed with an eating disorder. In addition to performing clinical assessments of hormonal status, the researchers administered a survey intended to assess dieting behavior. (This survey had been developed by the investigators and was based on the *Diagnostic and Statistical Manual of Mental Disorders, 4th edition* [DSM-IV] criteria for eating disorders.) Based on the results of the survey, women were divided into three groups: nondieters, intense dieters, and at-risk (pathological) dieters; intense and pathological dieting were not defined in the report, but pathological dieting was associated with significantly lower fat intake and a somewhat lower total energy intake as indicated by the food diaries the women were instructed to keep for two 3-d periods. During the 1-mo study, women who ovulated reported significantly higher intakes of energy, carbohydrate, and fat, and higher percentages of fat in their diets than women who did not ovulate or appeared to be at increased risk for amenorrhea (as determined by serum concentrations of estradiol and progesterone, and by menstrual history). The authors concluded that dieting practices that would not be considered diagnostic of a true eating disorder could increase the risk for amenorrhea. However, the validity of these findings is difficult to assess because the dieters and nondieters did not differ at the beginning of the study with respect to body mass index (BMI) or percent body fat. The authors did not indicate whether the women who were identified as dieters lost weight, and the survey of dieting practices had not been validated against other instruments.

In a study comparing young women (average age 26.2 ± 0.8 years) with irregular menses (oligomenorrhea) whose scores on the *Eating Attitudes Test* (Garner et al., 1982) indicated the presence of an eating disorder (n = 13) with those whose test scores indicated no eating disorder (n = 61), Dumoulin and coworkers (1996) found no difference between groups with respect to BMI, estradiol, dehydroepiandrosterone (DHEA), and several measures of luteinizing hormone

(LH) and follicle-stimulating hormone (FSH); however, those diagnosed with eating disorders had increased variability in their LH values and elevated testosterone levels. Among women with no evidence of eating disorders, LH variability was negatively associated with energy and carbohydrate intake (as measured using food diaries and interviews).

Eating restraint, defined as the conscious limitation of food intake to prevent weight gain, and assessed using a diagnostic instrument such as the *3-Factor Eating Questionnaire* (Stunkard and Messick, 1985), has been associated with alterations in the menstrual cycle such as shortened luteal phase, decreased progesterone surge, and failure to ovulate (Barr et al., 1994a; Schweiger et al., 1992). In the study by Schweiger and coworkers (1992), restrained eaters (n = 9) reported a 23 percent lower energy intake than unrestrained eaters (n = 13); however, in the study by Barr and coworkers (1994a), no significant difference was observed between high- (n = 9) and low- (n = 9) restraint eaters with respect to self-reported intake of carbohydrate, fat, or total energy; physical activity levels; BMI; or body fat. These authors theorize that self-reported food intake may be inaccurate, and that restrained eating behavior may influence menstrual status by acting as a stressor rather than by inducing negative energy balance.

Loucks and coworkers (Loucks, 1996) have shown that the decreased bone density in amenorrheic athletes is associated with decreased production of estrogen and suppression of pulsatile secretion of LH. Studies examining the effect of exercise and energy intake on athletic amenorrhea by Loucks and coworkers have shown that self-reported energy intake in both amenorrheic and eumenorrheic female athletes was lower than would be predicted by their physical activity level (as measured by activity monitors) and maintenance of body weight. Subsequent research by this group has shown that the decrease in LH pulsatility observed in amenorrheic athletes is due not to exercise per se but to the balance between energy intake and expenditure. A role for carbohydrate availability has also been hypothesized by this group (Loucks et al., 1996).

Dietary Fiber

Research performed and reviewed by Lloyd (1993) at a 1991 conference compared the diets of oligomenorrheic and eumenorrheic athletes and sedentary women (28 subjects in total). This study found that the athletes consumed significantly more energy, carbohydrates, calcium and phosphorous than nonathletes, while the only difference in dietary patterns between the oligomenorrheic and eumenorrheic athletes was that the oligomenorrheic athletes consumed approximately twice as much dietary fiber as their eumenorrheic counterparts. Lloyd proposed that the increase in dietary fiber was responsible for the hypoestrogenism and bone loss in this group. Decreased bone density was observed in both mildly and severely oligomenorrheic women. Interpretation of the results is confounded by small sample size as well as greater intake of calcium and phosphorous and lower body fat in the athletes compared with the sedentary women (see below). A similar pattern of decreased bone density and increased dietary fiber has been observed in vegetarian women. These associations suggest but do not prove that a relationship among energy balance, fiber intake, and body composition may influence menstrual status, bone density, and risk for musculoskeletal injuries. Lloyd has proposed two possible mechanisms to explain the bone loss. One possibility is that calcium bioavailability is significantly reduced in a

high-fiber diet. The other possibility is that dietary fiber may have an effect on estrogen metabolism and subsequent excretion, which would indirectly influence bone loss.

A number of studies have shown an inverse correlation between dietary fiber intake and plasma estradiol and/or estrone (Bagga et al., 1995; Boyd et al., 1997; Goldin et al., 1994; Kaneda et al., 1997; Rose et al., 1991, 1997), while others have observed no effect of dietary fiber by itself (Dorgan et al., 1996). Other reported effects of dietary fiber include decreases in estrone sulfate, testosterone, androstenedione, and sex hormone binding globulin (Goldin et al., 1994). Unfortunately, most studies that have shown a relationship between fiber and gonadal steroids have not ruled out the possibility that the observed effect is due to a decrease in fat or total energy intake. Two studies were conducted in such a way that the results may be interpreted to suggest that dietary fiber may exert an effect on gonadal steroids independent of the effects of other dietary factors. Goldin and coworkers (1994) placed 48 premenopausal women (27.1 ± 4.3 years) on a controlled 40 percent fat/12 g fiber/d diet for 4 weeks; subsequently, the subjects were placed on one of seven isocaloric experimental diets (20, 25, or 40% fat; 12 or 40 g fiber/d) for 8 weeks. The decreases in serum total estradiol and sex hormone binding globulin were primarily attributable to increased fiber. Rose and coworkers (1991) divided premenopausal women into three groups, each of which was asked to consume daily supplements of wheat, corn, or oat bran (15 g/d) for 2 months. An association was observed between supplemental wheat bran and decreases in estradiol and estrone with no decrease in dietary fat or energy from the previous diet.

Dietary Fat

Significant reductions in dietary fat have been associated with increases in the length of the follicular phase of the menstrual cycle (Reichman et al., 1992) and serum FSH levels; and decreases in serum estrone, estradiol (Bagga et al., 1995; Boyd et al., 1997; Goldin et al., 1994), estrone sulfate, testosterone, androstenedione, DHEA, sex hormone binding globulin (Goldin et al., 1994), and progesterone (Boyd et al., 1997).

The real effects of very low fat diets are difficult to determine because, as described earlier, these diets tend to be high in fiber and may be low in total energy; in addition, compliance with very low fat diets is difficult to determine and may be poor. The 2-mo feeding study by Goldin and coworkers (1994) described above, in which the effects of dietary fat could be separated from those of fiber, showed that fat intake was the primary contributor to the decrease in free estradiol, androstenedione, and testosterone. A long-term randomized control trial to examine the effects of a low fat, high carbohydrate diet on breast cancer risk among premenopausal women has shown that after 2 years, intervention subjects, whose food records show that they are consuming an average of 20 percent fat and 60 percent carbohydrate, have significantly decreased estradiol and progesterone and increased FSH compared to controls (Boyd et al., 1997). In a study of 90 premenopausal women by Dorgan and coworkers (1996), when the researchers examined 7-d food records and controlled for energy intake, the ratio of polyunsaturated to saturated fat in the diet appeared to be inversely related to serum estradiol and estrone levels during the luteal phase of the menstrual cycle, while total fat in the diet appeared unrelated to hormone levels.

The question must be asked whether the hormonal changes brought about by low fat or high fiber diets can be responsible for changes in menstrual status or ovulatory function. While a number of studies on the impact of low fat or high fiber diets on endocrine function have observed changes in the length of the luteal or follicular phase of the cycle, most have not addressed the question of whether ovulatory function changes. However, the study by Bagga and coworkers (1995), in which 12 healthy eumenorrheic women adhered to a 10 percent fat diet (containing 25–35 g/d fiber and approximately 1,500 kcal/d energy) for 2 months, observed no change in ovulatory function despite significant decreases in serum estrone and estradiol and a significant decrease in body weight and body fat.

Other Nutrients

Several groups of investigators have attempted to examine the influence of vegetarian diets on menstrual status, on the assumption that a vegetarian diet may be lower in saturated fat and/or higher in fiber than an omnivorous diet. A 6-mo study of 23 vegetarian and 22 nonvegetarian eumenorrheic women (20–40 years of age) assessed eating behavior by the *3-Factor Eating Questionnaire* and dietary intake by 3-d food records (Barr et al., 1994b). This study found that although vegetarian women tended to have lower BMI and body fat, and their menstrual cycles had longer luteal phases, these women actually showed less dietary restraint than the nonvegetarian women and had fewer anovulatory cycles. Although there were no differences between restrained and nonrestrained eaters with respect to energy, macronutrient, or fiber intake, eating restraint tendencies (as assessed by the survey) were associated with ovulatory dysfunction. No significant differences were observed between lacto-ovo-vegetarians (who consumed dairy products and eggs) and vegans (who consumed no animal products). The potential association of a vegetarian diet with amenorrhea is further complicated by the results of a recent population-based study comparing vegetarian adolescents (12–20 years of age) with a comparison group of nonvegetarians; this study found that vegetarian adolescents (81% of whom were female) were almost twice as likely to report frequent dieting, four times as likely to report intentional vomiting, and eight times as likely to report laxative abuse as nonvegetarians would (Neumark-Sztainer et al., 1997). Thus, at least among adolescents, vegetarianism may be a risk factor for disordered eating.

Inge and coworkers (1993) performed dietary assessments of a group of female ballet dancers and found that the calcium intake of amenorrheic dancers was significantly less than the RDA, while intakes of iron and zinc were adequate and significantly greater than the intake of these nutrients by eumenorrheic athletes.

Role of Body Fat

The possibility that menstrual status is influenced by percent body fat or fat distribution has been of considerable interest. While several investigators have found significant associations between percent body fat and amenorrhea among athletes or dancers (Crist and Hill, 1990; Frisch et al., 1992, 1993; To et al., 1997), others have found only weak or no associations (Estok et al., 1991; Hetland et al., 1995). A 1991 review of the studies to date concluded that while body fat

may show some correlation with menstrual status, there is no indication that body fat, per se, plays a role in regulating ovulatory function. Instead, the authors concluded, body fat appears to be an index of overall nutritional status and energy balance (Bronson and Manning, 1991). Finally, a recent study of 100 young women suffering from anorexia nervosa concluded that resumption of menses following commencement of treatment was associated with achievement of a critical weight but not with body fat (Golden et al., 1997).

Risk for Musculoskeletal Injury and Female Athlete Triad in Active-Duty Military Women

As reviewed earlier, numerous studies have shown that women in basic combat training (BCT) are at a greater risk for musculoskeletal injuries, including stress fracture, than are men in BCT. Risk factors identified by Jones and coworkers (1993) include aerobic fitness and higher and lower than average BMI, but not gender. Friedl (1996) reported that women with amenorrhea were at increased risk for stress fracture.

The prevalence of female athlete triad among active-duty military women has not been well studied. Dietary restriction of the severity associated with anorexia would be expected to be underreported by military women. However, research showing that brief periods of energy imbalance may increase the risk for amenorrhea suggests that active-duty military women may be at increased risk for amenorrhea simply as a result of chronic dieting and exercise. The role of nutrition as a risk factor in the stress fractures reported in women in BCT has not been examined.

Nutrient Adequacy of Weight Loss Diets

Dieters who participate in organized weight loss programs typically select foods that provide a nutritionally balanced diet but that are restricted in energy content (French and Jeffery, 1994; Neumark-Sztainer et al., 1996). There are few data on the adequacy of nutrient intake of dieters who diet on their own (French and Jeffery, 1994). In the development of the Food Guide Pyramid (USDA, 1992; Welsh et al., 1992) nutritionally adequate diets for gender/age groups over the age of 2 years were designed for energy intakes that ranged from 1,300 to 3,000 kcal. If a person selects foods in their lowest-fat form, with no added sugars, from the nutrient-bearing food groups and does not select from the fats, oils, and sweets group, the range in the number of servings from the Food Guide Pyramid would provide 1,220 to 1,990 kcal (Welsh et al., 1992). Thus, it is possible to have a nutritionally adequate diet that is relatively restricted in energy content. The role of such diets in promoting weight loss will depend on the balance of energy intake with expenditure. While the report by Welsh and coworkers describes the feasibility of designing nutritionally adequate, low-calorie diets, Nicholas and Dwyer (1986) analyzed the nutritional profile of 15 popular, weight-reducing diets and found that none of the diets, including those that recommended supplements, met the RDA for all vitamins and minerals. The nutrients that were most often inadequate were zinc, iron, folate, and B_6. However, as long as dieters focus on reducing high-fat (calorically dense) foods, it is possible to meet nutrient requirements.

Summary

Chronic dieting is associated with a number of health and behavioral consequences; these include a negative impact on cognitive function as determined by assessment of reaction time, vigilance, and short-term memory. Common dieting practices that would not be considered severe enough to constitute an eating disorder and may not result in significant changes in body weight or composition appear to increase the risk for amenorrhea and stress fracture, health problems previously believed to be associated only with more extreme energy depletion in the syndrome known as female athlete triad. Research has sought to elucidate the factors that contribute to the syndrome of female athlete triad, the result of a suppression of pulsatile pituitary secretion of LH, but its etiology remains unclear. Several possible dietary variables have been investigated including energy intake, the balance between energy intake and utilization, carbohydrate availability, dietary fiber, dietary fat, the ratio of fiber to fat, protein, and cholesterol intake. To date, it is not clear which of these factors or combination of factors are the most important. Evidence in support of a role for total body fat or body fat distribution in controlling menstrual function is contradictory and suggests that other factors, such as energy balance, may play a greater role. It is not possible at present to assess the impact of dieting practices among active-duty military women on their nutritional status. The prevalence of female athlete triad among these women and its possible contribution to the high level of stress fracture observed among women in BCT is also unknown.

INFLUENCE OF MILITARY OPERATIONAL RATIONS AND DINING HALL MEALS ON THE NUTRITIONAL STATUS OF ACTIVE-DUTY MILITARY WOMEN

Results of Military Nutrition Studies

Studies of selected groups of military women have found intakes of several nutrients to be below the MRDA for those nutrients. King (1996) and King et al. (1993) reported the results of several studies showing that women in the field consuming operational rations had intakes of energy and several nutrients (iron, calcium, and folate) that were less than in garrison and below the MRDAs.

The nutrient density of military rations may contribute to inadequate intakes if active-duty women are not able to consume the entire ration without feeling full or gaining weight, which is often the case since the nutrient density is based on intake of a level of energy that is considered adequate for the average male soldier (approximately 3,600 kcal/d).

A study of U.S. Military Academy, West Point, cadets in 1990 showed that a significant percentage of female cadets were at increased risk for iron deficiency anemia, although the number of women taking supplemental iron as well as the occurrence of a recent blood drive confounded interpretation of the results (Friedl et al., 1990). Analysis of food intake for 1 week revealed that female cadets were at risk for consuming low levels of folate (Klicka et al., 1993), although folate status was not analyzed in the 1991 study reported earlier.

A 1993 study of food consumed in garrison by 49 women in BCT at Fort Jackson, South Carolina (King et al., 1994) found that, contrary to previous expectations, the nutrient intake of women in garrison was not substantially greater than that in the field. Again, because the menu

offered in the dining hall was the same for men and women, nutrient analysis revealed that levels of vitamin B_6, folic acid, calcium, magnesium, iron, and zinc would be significantly below the MRDA for women who consumed the amount of energy required to maintain their weight. That is, the nutrient density of this menu did not provide the optimum amounts of these nutrients, according to the nutrient density standards of the MRDAs. Mean intakes as a percentage of the MRDA were: vitamin B_6 (76%), folic acid (65%), calcium (73%), magnesium (89%), iron (90%), and zinc (73%). These intakes, if accurate, indicate that, on average, at least two-thirds of the MRDA was consumed. Evidence from this same study also revealed that recent efforts to lower the fat content of dining hall menus (Department of the Army Military Nutrition Initiatives) has resulted in a significant decrease, from 1988 to 1993, in the percentage of women deriving 35 percent or more of their calories from fat, although the average fat intake for all participants did not decrease and is still approximately 33 percent (Westphal et al., 1995), above the 30 percent level recommended by the *Nutrition and Your Health: Dietary Guidelines for Americans* (USDA/DHHS, 1995). Total energy intakes were approximately the same from the 1988 study to the 1993 study.

The nutritional and health status of the same BCT class of women studied by King and coworkers (1994) was reported by Westphal and coworkers in 1995. Status of calcium, magnesium, the B vitamins, and vitamins C and A (as determined by standard clinical methods) improved or did not change during the course of BCT. The prevalence of iron deficiency (as defined by a serum ferritin level of less than 20 μg/liter) increased from 15 percent of the trainees at baseline to 19 percent at completion, which is significantly higher than in a comparable civilian population (Westphal et al., 1995). However, some questions were raised by the CMNR regarding the clinical parameters used to define iron status in the Westphal study (IOM, 1995b). Anemia (as defined by a hemoglobin of less than 12 g/dl) was associated with poorer performance on the physical fitness test, although there was improvement in endurance in all subjects over the course of BCT. Serum folate levels were in the low-normal range and declined throughout the course of BCT. Finally, although serum calcium status appeared to be normal, the incidence of stress fracture among these and other women in BCT and the low calcium intake provided by the dining hall menu suggested that calcium balance may be of concern, although it is unlikely that brief decreases in calcium balance are associated with stress fracture (Personal communication, B. Specker, South Dakota State University, Brookings, 1998).

Finally, because national surveys have reported that many civilian women in the United States do not consume adequate amounts of some nutrients, such as iron and calcium (NHANES III, *Third Report on Nutrition Monitoring in the U.S.*), there is reason to believe that even active-duty women who consume the majority of their meals in nonmilitary locations are at risk for inadequate intakes of these nutrients. Friedl and coworkers (1990) found in their study of U.S. Military Academy cadets that nutritional status was positively associated with the percentage of meals consumed in the dining hall.

The majority of active-duty military women reside in barracks (quarters) or in private homes and consume the majority of their meals, not in military dining halls or as operational rations, but in the same settings as civilian women. No studies could be identified that have evaluated the nutritional status of active-duty women in situations other than BCT and brief field-training exercises. Thus, it is impossible at this time to evaluate the nutritional status of most active-duty women.

A large-scale survey of nutrition knowledge and attitudes and food intake practices among active-duty Army personnel worldwide, *The Army Food and Nutrition Survey 1996*, was recently completed. Of the approximately 3,000 respondents to this survey, nearly 500 were women. Data gathered in the survey show, for example, that women averaged approximately 2.9 servings per day of vegetables and 2.5 servings of fruit (in comparison, the 1991 *Five a Day for Better Health Survey* showed that 49% of women consumed 2.5 to < 5 servings of fruits and vegetables per day [DHHS, 1991]). Active-duty Army women also consumed an average of 1.8 servings of meat, 2.3 servings of dairy foods, 0.2 servings of grains, 0.6 servings of (breakfast) cereals, and 0.2 servings of legumes per day. The data appeared to suggest that women who held meal cards (ate the majority of their meals in the military dining facility) had a greater intake of fruits, vegetables, dairy products, grains, meat, and french fries per day than those who ate their meals off-post (Warber et al., in preparation). Data on the associations among individual dieting behavior, nutrition knowledge and attitudes, and food intake were not available as of yet from the survey. In addition, no information was available from the survey on the actual nutrient intakes of the respondents or on their nutrient status, and because the survey was anonymous, the results could not be linked to medical records.

Under another Defense Women's Health Research Program grant, James P. DeLany and coworkers are in the process of evaluating energy utilization by female Army personnel in a variety of work situations (IOM, 1996a). Complete assessment of the energy requirements of the average woman soldier will have to await analysis of the results of this and other studies.

Impact of Altered Nutrient Status

The data on nutrient status of active-duty women suggest that in both field and garrison dining situations, women are at increased risk for inadequate iron, calcium, and folic acid intake. The potential consequences to performance and health of deficiencies in these nutrients as well as in protein will be reviewed briefly.

Iron

A prolonged inadequate dietary intake of iron can lead to iron deficiency, which may have adverse physical and cognitive effects independent of those associated with restricted energy intake. These effects include depressed immune function, impaired cognitive development, behavioral disturbances (pica), impaired body temperature regulation, and reduced exercise and work performance (Beard et al., 1996). The negative effects have been associated primarily with iron deficiency anemia; the impact of iron deficiency without anemia is more subtle and difficult to detect (Beard et al., 1996).

Physical performance and iron. Iron deficiency anemia is responsible for a significant decrease in work capacity, particularly when hemoglobin concentrations fall to less than 10 g/dl. The decrease in maximum oxygen consumption ($\dot{V}O_2max$) is related to the decrease in the capacity of blood to transport oxygen. The effect of iron deficiency without anemia on work ca-

pacity was thought to be inconsequential; however, recent data (Zhu and Haas, 1997) show that $\dot{V}O_2$max and endurance in iron-depleted women without anemia are reduced and related to serum ferritin concentration (the index of iron storage) but not to hemoglobin.

Cognitive function and iron. Most studies on iron status and cognition to date have focused on infants and schoolchildren and have reported a negative impact of iron deficiency on behavior and development. It is unclear whether these deficits are reversible with iron treatment (IOM, 1993). Only a few studies have examined the impact of iron deficiency on cognitive function in adolescents and adults. Iron-deficient adolescent and young adult women who received iron treatment had better cognitive function than controls in several studies (Ballin et al., 1992; Bruner et al., 1996; Groner et al., 1986; Webb and Oski, 1973). However, one cross-sectional study of iron status in young adults reported no relationship between low iron stores and cognitive function, (Fordy and Benton, 1994). A study is in progress by Sandstead (1996) and coworkers to examine the role of iron supplementation and iron deficiency in the cognitive function of active-duty military women. More data in this area are needed, but the potential negative cognitive effects of iron deficiency and anemia, coupled with its negative physical effects, underscore the need to ensure that military women consume adequate amounts of iron to ensure readiness.

Impact of exercise on iron status. Most studies examining iron status and exercise have focused on highly trained athletes and have reported that iron losses are higher in endurance-trained athletes than in the reference groups (Weaver and Rajaram, 1992). A few studies report on the impact of exercise on the iron status of sedentary women as they first begin fitness exercise. Most of these studies found an initial decline in iron status (beyond that associated with hemodilution) among women at the start of the exercise program (Hegenauer et al., 1983; Kilbom, 1971; Lyle et al., 1992; Rajaram et al., 1995; Rowland et al., 1988). Data are conflicting on whether adaptation of iron status to fitness exercise occurs without increased iron intake via supplements or meat (Blum et al., 1986; Lyle et al., 1992; Rajaram et al., 1995). Athletes with iron deficiency severe enough to result in anemia improved their work performance with increased iron intake through food or supplements (Karamizrak et al., 1996), but the impact of increased iron intake on performance in nonanemic, iron-depleted athletes is less certain (Clarkson and Haymes, 1995; Karamizrak et al., 1996). Some preliminary evidence suggests that iron supplementation of nonanemic women can improve aerobic capacity (Personal communication, J. Haas, Cornell University, Ithaca, N.Y., 1997).

Calcium

A prolonged inadequate intake of calcium may have negative effects on skeletal health. An adequate calcium intake is important for attaining peak bone mass during adolescence and early adulthood and maintaining skeletal mass after that time (Heaney, 1996).

Military women have the advantage of an active lifestyle. A recent review of 17 studies with mostly peri- and postmenopausal women concluded that a positive effect of physical activ-

ity on bone density appeared to exist only at calcium intakes greater than 1,000 mg/d and that the beneficial effect of high calcium intake only appears to be present when there is physical activity (Specker, 1996). It is not clear whether this association is also true in younger women.

The MRDA for calcium is set at 800 to 1,200 mg to reflect the range of ages of active-duty women. In comparison, the adequate intakes (AIs) reported by the Institute of Medicine for women aged 19 to 50 years are 1,000 mg/d, with AIs for girls aged 14 to 18 years set at 1,300 mg/d (IOM, 1997). While it appears that the MRDA level of calcium intake should be adequate to meet the needs of most military women, many women relying on operational rations as well as those consuming their meals in military dining facilities are at risk for inadequate calcium intakes unless they choose their foods carefully.

Folate

Randomized control trials have shown clear evidence that periconceptional supplementation with folic acid can lower the risk of neural tube defects in the offspring of women who have had previous pregnancies with neural tube defects. These data have led to the recommendation that (1) women of childbearing age take 400 μg/d of supplemental folic acid and (2) that food processors add folic acid to some staple food ingredients (grains). Although the MRDA for folic acid is 400 μg/d, which is the amount supplied by operational rations, the results of food intake surveys have shown that many active-duty women do not consume a full day's rations or dining hall meals. In view of these practices and the relatively high incidence of unplanned pregnancy among active-duty women (Thomas and Edwards, 1989), additional measures are necessary to ensure that these women receive adequate folate.

Protein

The tenth edition of the RDAs states, "There is little evidence that muscular activity increases the need for protein, except for the small amount required for the development of muscles during physical conditioning . . . In view of the margin of safety in the RDA, no increment is added for work or training" (NRC, 1989, pp. 70–71). However, in a recent review, Lemon (1997) summarizes pertinent studies, and he suggests that the RDA for protein for active individuals may be 1.5 to 2.2 times the current RDA; that is, he concludes that the RDA for endurance athletes should be about 1.2 to 1.4 g protein/kg/d and the RDA for strength athletes should be 1.7 to 1.8 g protein/kg/d. He notes that with sufficient energy intake, these intakes can be obtained without difficulty from diets that provide 10 percent energy as protein (Lemon, 1997). The MRDA for protein for women is 80 g/d, which for women in the weight range 46 to 63 kg allows 1.74 to 1.27 g/kg/d, respectively. This intake is higher than the RDA for protein and appears to be more than adequate for women engaging in moderate activity. The issue of protein requirements and intakes of both male and female military personnel will be considered in depth in a forthcoming report by the BCNH committee and the CMNR.

Energy

MRDA allowances for energy reflect moderate activity levels. Military occupational specialties requiring greater strength do not necessarily have higher energy requirements, and the frequency and duration of strength-requiring activities will influence energy expenditure.

Fluids

Research has shown that dehydration resulting from insufficient fluid intake and exposure to environmental extremes can impair physiological function and may affect cognitive function by impairing balance (IOM, 1996b). Results of a survey conducted by the Air Force (Voge and King, 1996) suggest that active-duty women in positions that involve air flight may restrict fluid intake to avoid the need to eliminate the fluids while in flight. In addition, anecdotal evidence presented at the 1996 workshop held in Irvine, California, suggested that women in field operations restrict fluid when private facilities are unavailable or difficult to reach. In response to a recommendation that appeared in a CMNR report on fluid intake (IOM, 1994), a water doctrine was established by the Army emphasizing the need to enforce adequate fluid intake.

Summary

Only a small number of military nutrition studies have included women, and of those that have, nearly all have studied dietary intake or nutrient status of soldiers in brief field training sessions, cadets enrolled at military academies, or new recruits in BCT. Operational rations and dining hall menus are formulated based on the MRDAs for male soldiers. Thus, nutrient analysis has shown that the density of several key nutrients is low compared to nutrient density standards of the MRDAs; that is, women who limit their food consumption in these situations to balance energy intake and expenditure may experience inadequate intakes of calcium, iron, and folate unless careful choices are made. Nevertheless, intake analysis in a study of women in BCT indicated that, on average, at least two-thirds of the MRDAs of these nutrients were consumed. Except for folate and iron, nutrient status improved or did not change during the course of the training period; the prevalence of iron deficiency increased from 15 percent at baseline to 19 percent at completion. No studies could be identified that assessed the nutritional status of active-duty women in situations other than training and brief field exercises. The majority of active-duty women reside in military or private quarters and consume the majority of their meals in the same settings as civilian women, and while it is impossible at this time to evaluate their nutritional status, there is little reason to believe that it is significantly different than that of civilian women of comparable age, socioeconomic status, educational achievement, and activity level. National surveys have suggested that many civilian women consume diets that place them at risk for low calcium and iron intake. A large-scale survey of nutritional knowledge and attitudes and food intake practices of active-duty female Army personnel has recently been completed. It is not clear whether the information gathered will permit an assessment of the actual nutritional status of active-duty women in garrison.

Studies in the civilian sector on the impact of prolonged inadequate intake of iron have shown effects on physical and cognitive task performance and depressed immune function. In addition, strenuous exercise increases iron losses. Inadequate calcium intake during young adulthood may inhibit attainment of peak bone mass and later maintenance of skeletal mass. Physical activity exerts a positive effect on bone density in peri- and postmenopausal women when daily calcium intake is adequate; it is unknown if this association is true for younger women. Periconceptional folate supplementation may decrease the risk of neural tube defects among the offspring of women who have given birth to an infant with a neural tube defect. This has led to the recommendation that all women of childbearing age take 400 μg/d of supplemental folic acid. Although recent recommendations for higher intakes of protein among physically active individuals are controversial, the MRDA for protein appears to be more than adequate. This issue will be considered further in an upcoming report by the CMNR. MRDA allowances for energy reflect moderate activity levels. Although little attention has been given to active-duty women of very low BMI, the additional energy sources available in operational rations and supplemental ration components allow for increased needs. Finally, evidence suggests that increased emphasis must be placed on adequate fluid consumption, particularly among women whose military occupational specialties involve airborne operations.

CONCLUDING REMARKS

The average active-duty woman appears to face the same nutritional risks as her civilian counterparts. Military service creates the added pressure for many women of needing to practice weight control, although like their civilian counterparts, the number of active-duty women who perceive themselves as overweight and who are restricting intake exceeds the number who in fact need to lose weight. The only information currently available on the nutritional status of active-duty women is based on studies of women who are in temporary training situations and suggests that their intake of calcium, iron, and folic acid during these periods may be inadequate. Research suggests that this may have immediate negative consequences for their ability to perform both physically and cognitively. The long-term consequences, if any, of these periods of inadequate intake as well as the effects of more prolonged subsistence on rations during deployment are unknown. In addition, the effects of exposure to the environmental extremes encountered during deployment on active-duty women's health and nutritional status have not been explored.

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6

Pregnancy and Lactation and Postpartum Return-to-Duty Fitness

MILITARY POLICIES ON PREGNANCY AND POSTPARTUM ATTAINMENT OF WEIGHT/FAT AND FITNESS STANDARDS

Prior to 1972, active-duty women were separated involuntarily from the military if they became pregnant. In 1972, this policy was amended, and provision was made for exceptions to separation on an individual basis. In 1975, the discharge policy was abandoned following several challenges to its constitutionality. Today, pregnant women who wish to remain in the service may do so. Department of Defense (DoD) policy has been that separation from the service for pregnancy is an option and with minor exceptions, pregnant women cannot be involuntarily discharged. Enlisted women are not separated for pregnancy/childbirth unless it is in the best interest of the servicemember (Thomas and Thomas, 1992). Current military policies on pregnancy and the postpartum period are summarized in Table 6-1. Data on the marital and parental status of active-duty women are summarized in Tables 6-2 and 6-3. In general, pregnant servicewomen are considered nondeployable (Army) or restricted from certain work environments and duties (all services), and are removed from sea duty by the twentieth week of pregnancy (Navy, Marine Corps, and Coast Guard). Prior to the twentieth week, pregnant women are allowed to remain on sea duty if, in an emergency situation, medical treatment can be obtained within 6 hours (Navy and Marine Corps) or 3 hours (Coast Guard). Women are required to return to full duty after 6

TABLE 6-1 U.S. Military Practices and Policies for Female Personnel: Pregnancy and Postpartum Periods

Period	Army	Navy	Air Force	Marine Corps	Coast Guard
Pregnancy	•Exempt from body composition, fitness testing (AR 40-501, 1995) •Nondeployable •At 20 weeks, standing at parade rest/attention < 15 minutes •At 28 weeks, 40-h week/8-h day	•Exempt from body composition, fitness testing •20-wk Rule (no shipboard duty after 20th week of gestation) •6-h Rule (medical evacuation for ER must be within 6 hours) (OPNAVINST 6000.1A, 1989) •40-h work week •Standing at parade rest/attention no more than 20 minutes	•Exempt from body composition, fitness testing •Restrictions based on work environment •Pregnant members assigned to areas without obstetrical care will have assignment curtailed by 24th week (AFI 44-102, 1996)	•Full-duty status and deployable until medical officer certifies that full duty is medically inadvisable •May not participate in contingency operations or be deployed for operations aboard Navy vessels •Flight personnel are grounded unless cleared by medical waiver •Excused from duties (physical training or standing in formation) that in the opinion of the medical officer are hazardous to her health or to her unborn child •Remains available for worldwide assignment •Pregnant Marines stationed in Hawaii will not be detached after their 6th month; if overseas, they may be detached at their normal rotation tour date; if assigned to shipboard duty, the Marine will be reassigned at first opportunity and no later than the 20th week of pregnancy	•Exempt from body composition testing •>28 weeks, 40-h work week; no overseas duty •Other duty restrictions based on work environment; no rescue swimmer duties •Not deployable during 20th week through 6 months postpartum •Time to medical evacuation for emergencies < 3 hours •No flight duties after 2nd trimester •Prenatal sick leave not to exceed 30 days

Postpartum	•Return to duty at 6 weeks •Exempt from weigh-in until 6 months •Physical training at own pace for 45 days •Exempt from fitness testing for 135 days (FM 21-20, 1992) •Deferment from deployment until 4 months postpartum •No policy regarding breastfeeding	•Return to duty at 6 weeks •Exempt from weigh-in until 6 months •Exempt from fitness testing for 6 months •Deferment from deployment until 4 months postpartum •No policy regarding breastfeeding	•Return to duty at 6 weeks •Exempt from weigh-in until 6 months •Deferment from deployment until 4 months postpartum •Exempt from fitness testing for 6 months (AFI 40-502, 1994) •Commander may approve up to 18 months deferral •No policy regarding breastfeeding	•Return to duty at 6 weeks (or as soon after delivery as medical officer certifies) •Exempt from weigh-in until 6 months •Exempt from fitness testing for 6 months •Deferment from deployment until 4 months postpartum •(MCO 5000.12D, 1995) •No policy regarding breastfeeding	For nursing mothers, the 6-mo weight standards exemption following delivery will begin at the conclusion of the nursing period, but no later than 12 months postdelivery •Postdelivery maternity leave up to 6 weeks •Not deployable until 6 months postpartum •Exempt from weight standards for up to 6 months

NOTE: AR, Army Regulation; OPNAVINST, Naval Operations Instruction; AFI, Air Force Instruction; FM, Field Manual; MCO, Marine Corps Order. A more detailed table appears in Appendix B.

TABLE 6-2 Percentage of Married U.S. Military Active-Duty Women by Rank and Service as of September 30, 1996

Rank/Age (years)	Army (%)	Navy (%)	Marine Corps (%)	Air Force (%)
Enlisted women				
17–25	33	30	33	42
26–40	61	57	60	65
41–65	55	56	52	66
Warrant officers*				
17–25	50	100		
26–40	62	57	64	
41–65	60	67	41	
Officers				
17–25	34	23	22	33
26–40	60	56	57	62
41–65	59	57	55	61

* The Air Force does not have personnel classified as warrant officers.

SOURCE: Defense Manpower Data Center (Rosslyn, Va., 1996).

TABLE 6-3 Parental Status of U.S. Military Active-Duty Women

	Army (%)	Navy (%)	Marine Corps (%)	Air Force (%)
Enlisted women				
Not a parent	58	69	75	67
Married parent	27	19	16	23
Single parent	15	12	9	9
Total parents*	42	31	25	32
Warrant officers†				
Not a parent	49	44	51	
Married parent	36	40	32	
Single parent	15	16	17	
Total parents	51	56	49	
Officers				
Not a parent	69	73	83	70
Married parent	24	22	13	25
Single parent	6	5	3	5
Total parents	30	27	16	30

* Married and single.

† The Air Force does not have personnel classified as warrant officers.

SOURCE: Defense Manpower Data Center (Rosslyn, Va., 1996).

weeks postpartum unless on medical waiver, and must comply with weight standards by 6 months. Army women must comply with fitness standards by 135 days; women in the other services are allowed 180 days. According to DoD Directive 1315.7 (1991), women in all services are deployable after 4 months postpartum, unless they receive a medical waiver.

PROFILE OF MILITARY WOMEN AND RISK FACTORS FOR POOR PREGNANCY OUTCOME

Military service may involve a variety of factors that pose a risk to successful pregnancy outcome in active-duty women. These factors include the profile of the military woman herself, dietary habits, pressures to meet body weight standards, and service work environments. For example, in a study that compared pregnant active-duty Navy women with civilian female Navy spouses, active-duty women were younger (22.5 vs. 23. 5 years), more often single (33 vs. 6%), and less likely to have progressed beyond a high school education (50 vs. 70%). Active-duty women reported more prenatal visits (13.6 vs. 12.6) and less social support (*Support Behaviors Inventory* score of 101.85 vs. 109.37) (Messersmith-Heroman et al., 1994).

Nutritional surveys have revealed suboptimal iron and folate status among some military women, which poses a risk during pregnancy. A study conducted at Fort Jackson, South Carolina, indicated that 56 percent of the female Army soldiers at the beginning of basic combat training (BCT) had ferritin levels less than 20 ng/ml, although hemoglobin levels were normal. Many of these women were in marginal iron status and did not improve or actually worsened through basic training. Mean serum folate was in the low normal range and declined significantly over the 8-wk training period (Westphal et al., 1995).

Women who are thinner prior to pregnancy are at risk for giving birth to infants with lower birthweights (IOM, 1990). The prevalence of underweight (body mass index [BMI, weight in kilograms divided by the square of the height in meters] < 19.8) servicewomen was 14.5 percent for ages younger than 20 years, 11.3 percent for 20 to 25 years, 9.8 percent for 26 to 34 years, and 4.9 percent for 35 years or older (Personal communication, R. M. Bray, Research Triangle Park, N.C., 1996; see Table 6-4).

In addition, studies have shown adverse effects on pregnancy outcome of long work hours, heavy lifting, and chemical and infectious disease exposures (Keith and Luke, 1991; Mamelle et al., 1984). Premature birth has been associated with occupational fatigue factors such as prolonged standing and physical work. In a case control study of nurses (N = 210 cases and N = 1,260 controls), factors associated with preterm birth included hours worked per week, per shift, and while standing; noise; physical exertion; and occupational fatigue score (Luke et al., 1995). The adjusted odds ratios were 1.6 for hours worked per week (< 36 vs. > 36 h/wk), and 1.4 for fatigue score (< 3 vs. > 3).

Military women experience many of these work-related factors. Active-duty Navy women (N = 100) worked longer into pregnancy (37.27 vs. 32.74 weeks) and longer hours (39.18 vs. 36.12 h/wk), and reported lower levels of social support than did their civilian counterparts (N = 100) (Messersmith-Heroman et al., 1994). Until the third trimester, most pregnant Navy

TABLE 6-4 Prevalence of Underweight as Determined by a Body Mass Index of Less Than 19.8 for U.S. Military Active-Duty Military Women

Characteristic	(*N*)	Prevalence
Service		
Army	678	10.4 (1.5)
Navy	826	7.1 (0.9)
Marine Corps	569	12.6 (1.3)
Air Force	826	10.8 (1.1)
Age		
<20	184	14.5 (3.8)
20–25	1,040	11.3 (1.2)
26–34	887	9.8 (1.0)
35+	788	4.9 (1.1)
Race/ethnicity		
White	1,774	10.6 (0.9)
Black	680	7.6 (1.4)
Hispanic	251	11.9 (2.3)
Other	194	8.6 (2.0)
Rank		
Enlisted	2,293	9.4 (0.8)
Officer	606	11.9 (1.6)
Total	2,899	9.8 (0.7)

NOTE: Prevalence estimates are percentages with standard errors in parentheses.

SOURCE: *Survey of Health-Related Behaviors among Military Personnel* (Personal communication, R. M. Bray, Research Triangle Park, N.C., 1996).

women ($N = 486$) worked normal shifts and hours in their assigned jobs (Thomas et al., 1991). There was some evidence that pregnant women would be transferred off ships before 20 weeks. Frequently mentioned hazards included toxic chemicals, fuels, fumes from paints, and other products. Less frequently mentioned hazards were noise, x rays, electric shock, and radiation.

The risk of radiation exposure of the fetus during high-altitude or space flight poses the single biggest medical concern in allowing women access to all aviation and space careers. Orthostatic intolerance during flight may contribute to lower gravitational tolerance during pregnancy. There is a chance of incapacitation due to spontaneous abortion, nausea and vomiting, weight gain, and unsteadiness. Spontaneous fetal loss was increased in flight attendants compared with the general population (relative risk, RR = 1.9) (Lyons, 1992).

Summary

Women who become pregnant while serving on active duty may face a variety of factors that present a risk to the developing fetus as well as to themselves. These may include dietary habits that result in low iron or folate status; underweight or the pressure to meet body weight standards; young age; lack of social or spousal support; work-related factors such as prolonged standing, heavy lifting, and toxic exposures; and the likelihood that the pregnancy is unplanned.

REPRODUCTIVE HISTORY OF MILITARY WOMEN

Pregnancy Prevalence

In fiscal year 1996, 13,423 active-duty women had a child by birth or adoption. Table 6-5 shows the distribution by rank and service.

Navy

Incidences of pregnancy and single parenthood were studied among 2,000 enlisted personnel in the Navy (Thomas and Edwards, 1989). Pregnancy rates of Navy women were similar to civilian age cohorts (13% on an annual basis), and pregnant women constituted 1.4 percent of enlisted forces. Pregnancy rates were highest among women in pay grades E-4 and below and among women in their first enlistment. Women on ships had a lower pregnancy rate than those assigned ashore. Surveys show that 60 percent of pregnancies were unplanned. Military medical facilities were used by 73 percent of women for their prenatal care. Probably as a consequence, the abortion and miscarriage/ stillbirth rates of Navy women were lower than those of civilians (abortions are not performed at military facilities). The proportion of single parents in the Navy (3% males and 14% females) is twice that of the civilian population. Single parenthood was more characteristic of personnel in their second and subsequent enlistments than among first termers. First-term retention of Navy women lags behind that of men by 5 percent, with pregnancy as a major cause of retention losses (Rowe, 1994). In subsequent enlistments, retention of women is higher than for men.

TABLE 6-5 Percentage of Active-Duty Women Who Had a Child in Fiscal Year 1996

Rank	Army (%)	Navy (%)	Marine Corps (%)	Air Force (%)
Enlisted	8	7	7	7
Warrant officers*	4	5	10	
Commissioned officers	6	5	4	5

* The Air Force does not have personnel classified as warrant officers.

SOURCE: Defense Manpower Data Center (Rosslyn, Va., 1996).

According to Thomas and Edwards (1989), policies regarding pregnancy were not well understood or enforced. Fewer than half of the male first-class and chief petty officers were correctly informed about Navy pregnancy policy, in particular, regulations affecting women in ships.

According to 1990 Bureau of Naval Personnel (BUPERS) records, 90 percent of the 50 Navy women discharged for pregnancy were in their first enlistment. The discharge rate was highest among those who were married to another military member and lowest among single women. Although pregnancy is a major reason for women to be discharged, pregnancy accounted for only 3.5 percent of all military discharges from the Navy in 1990. Fewer than 20 percent of supervisors thought that pregnant women had a negative effect on the workload of others.

A survey of psychosocial and behavioral correlates of pregnancy aboard Navy ships revealed that 4.2 percent of the 2,032 respondents were pregnant at the time of the survey; 30 percent were on sea duty when they became pregnant (Thomas, 1996). Only 27 percent of these pregnancies were planned, whereas 50 percent of pregnancies on shore were planned. Pregnant women were younger and more likely to be married than were nonpregnant sailors. Pregnancy rates were not related to education, race, or stress measures. Birth control was used by 59 percent of the sample. Of the remaining 41 percent, 14 percent were not sexually active, 13 percent were sterile, and 14 percent used no birth control method.

Marine Corps

Pregnancy rates in the Marine Corps are at levels either equal to or lower than rates in the general population (Flatter, 1996). Women's attrition rates have been decreasing steadily in the Marine Corps. Nevertheless, attrition for over 50 percent of all female (and 30% of males) Marines occurs for one reason or another before completion of their first enlistment. Pregnancy is a major contributor to this high attrition among women. In 1991, the pregnancy attrition rate for women was 13.2 percent (overall attrition = 54.1%). Unplanned pregnancies, which account for the majority of pregnancy attrition cases, are common. Despite military policy prohibiting abortion, the incidence of abortion among women in the Marine Corps is believed to be at least as high as that in the general population (Flatter, 1996).

Army

According to the *Army Sample Survey of Military Personnel*, 8 percent of enlisted females, 4 percent of warrant officers, and 6 percent of officers reported giving birth during fiscal year 1996 (Table 6-5).

Air Force

Prevalence rates of pregnancy among Air Force servicewomen were obtained from the Air Force Office of Medical Logistics. As of June 30, 1997, 5 percent of enlisted women and 3 percent of officers reported being pregnant. Enlisted women 20 to 24 years of age reported the

highest pregnancy rate, just over 6 percent. During fiscal year 1996, 7 percent of enlisted women and 5 percent of officers reported giving birth (Table 6-5).

Civilians

Taking the most recent civilian data available (Ventura et al., 1997), the percentages of females in each age group who gave birth in 1996 were as follows: 8.7 percent of those aged 18 to 19 years; 11.1 percent of those aged 20 to 24 years; 11.4 percent of those aged 25 to 29 years; and 8.5 percent of those aged 30 to 34 years. Thus pregnancy rates for civilian women are significantly higher than for active-duty women at all ages.

Pregnancy Course and Outcome

Although DoD service-wide statistics are not available, studies suggest that pregnancy complications and preterm delivery may be more prevalent in military women than in their civilian counterparts.

A survey compared deliveries within the DoD military health care system in 1980 (N = 100,351) with deliveries in civilian hospitals (N = 3,762,000) (Horton et al., 1988). Compared with civilian hospitals, military hospitals had a higher percentage of Caucasian women (73 vs. 70%) in their twenties (72 vs. 64%) than did civilian hospitals. A lower proportion of deliveries in the military population were uncomplicated compared with the civilian (39 vs. 49%), regardless of age or race. However, the definition of uncomplicated delivery was rather restrictive in the military. In DoD hospitals, average stays compared with civilian hospitals were longer (3.3 vs. 3 days) for uncomplicated deliveries. Horton et al. (1989) examined the use of obstetrical care among military (all services) and civilian families. Military families (N = 407) were defined as having at least one parent on active duty; thus, these data represent female soldiers and civilian wives of soldiers. Comparing military with civilian women, the initial prenatal visit occurred in the first trimester for 57 versus 64 percent, in the second trimester for 32 versus 29 percent, and in the third trimester for 11 versus 6 percent, respectively. These data contrast with results from a self-report survey of all four services showing that 82 percent of active-duty women received prenatal care in the first trimester of their most recent pregnancy (Bray et al., 1995). Mean birthweight (3,200 g), gestational age (39 weeks), and Apgar scores (8/9) were not significantly different between groups. It should be emphasized that the studies by Horton are based on data from a 1980 survey. Thus, many factors, including the ethnic diversity of the military population, have changed considerably. Further, there was no indication of the proportion of soldiers in the population studied.

To describe pregnancy experiences in the military, a survey was conducted in which 345 active-duty obstetric patients from the Army, Air Force, Navy, and Marine Corps were interviewed (Evans and Rosen, 1996). Of the respondents, 76 percent were married, 55.4 percent of the pregnancies were planned, and 51 percent of the women did not believe there was a good time to become pregnant in one's military career. The majority of women reported that pregnancy had no effect on their career opportunities. Fifty-eight percent had been pregnant at least

once. Reproductive history revealed the following past pregnancy problems: 15 percent had premature deliveries, 26 percent had abortions, 43 percent had miscarriages, and 22 percent had cesarean-section deliveries. Self-reported problems during the current pregnancy were as follows: 55 percent had no pregnancy complications, 26 percent had one problem, 10 percent were confined to bedrest, 7 percent were hospitalized; and 12 percent were exposed to hazardous materials. Since being pregnant, many reduced their use of alcohol (59%), cigarettes (22%), or caffeine (81%), although many had never used alcohol (39%), cigarettes (75%), or caffeine (12%).

Only 20 percent of participants had work reassignments due to their pregnancy because of physical requirements (34%), exposure to hazardous chemicals (12%), both (49%), or for undisclosed reasons (6%). Those who were reassigned reported greater psychological distress, harassment-discrimination, work absences, medical problems, and intentions to leave the organization. Of those reassigned, however, 80 percent agreed that reassignment was necessary. The study showed that the work experiences of the pregnant military women played a primary role in their decisions to leave. The extent to which pregnancy was perceived and treated positively or negatively contributed to attrition and, therefore, to military readiness. This finding contradicted Navy data, described earlier, on the perspective of supervisors regarding pregnancy and its interference with duties.

In contrast to the considerable number of studies on the influences of pregnancy and childbirth themselves on the military work environment, few studies have examined the impact of multiple pregnancies (family size) on operational effectiveness. Overall, 65 percent of active-duty women are childless, approximately 19 percent have one child, 11 percent have two children, and 4 percent report 3 or more children (this last figure varies by service and rank from 2.3 to 5.5%); thus, 15 percent of active-duty women have 2 or more children (Table 6-6). A study of active-duty Navy personnel to determine whether there were gender differences in absenteeism rates from duty (as measured by supervisor-completed work diaries) found that in shore commands, 11 minutes more work time was lost per day by parents than by nonparents, but there was no difference in lost work time between male and female parents. Single and married parents lost equal amounts of work time (Thomas et al., 1993). When data from a self-report survey conducted recently across all services were used to examine the effect of family size on self-perceived work performance or lost work time, no effect was found (Evans and Rosen, 1996).

Army

Severe antenatal morbidity was common among healthy women (N = 1,825) enlisted in the Army (Adams et al., 1994). Pregnant women (27%) were hospitalized antenatally for the following reasons: preterm labor (44%), preeclampsia (10.3%), hyperemesis (5.5%), and urinary tract or kidney infection (4.7%). African American enlisted women in the Army had a cumulative probability of preterm delivery (13.5%) that was higher than that for Caucasian enlisted women (10.5%) (Adams et al., 1993). Hazard ratio was not uniform across all gestational ages. The African American/Caucasian difference was not significant at 33 to 36 weeks, when most

TABLE 6-6 Parity among Active-Duty Servicewomen (Expressed as Percentage of Total Number of Women in that Service and Rank) as of June 1997

Service	Rank	0 Children	1 Child	2 Children	3+ Children
Army	Enlisted	57.7	22.9	13.9	5.5
	Officer	67.9	16.1	11.7	4.3
Air Force	Enlisted	67.7	18.8	10.2	3.3
	Officer	69.5	13.6	11.9	5.0
Marine Corps	Enlisted	76.1	15.3	6.3	2.3
	Officer	77.7	10.2	8.3	3.7
Navy	Enlisted	67.9	19.8	9.2	3.0
	Officer	71.4	13.3	10.9	4.4
Total	Enlisted + Officer	65.4	19.4	11.2	4.1

SOURCE: Defense Manpower Data Center (Rosslyn, Va., 1997).

preterm deliveries occur, nor for spontaneous rupture of membranes or idiopathic preterm labor, the most common causes of preterm delivery. African American-Caucasian hazard ratios were greatest and significantly different for all deliveries before 33 weeks and for medically indicated preterm deliveries that were required because of severe preeclampsia, fetal growth restriction, or fetal compromise. Caucasian servicewomen had slightly higher rates of preterm delivery compared with their civilian counterparts, whereas African American servicewomen had rates that were less than would have been expected (Adams et al., 1995).

In a case control study (N = 604 preterm cases and N = 6,070 controls) of active-duty primigravidas in the Army, those employed in the highest physical activity levels (heavy and very heavy) had increased odds of preterm delivery ranging from 1.69 to 1.75 (Ramirez et al., 1990). In a logistic model, three independent predictors for preterm delivery were identified: physical activity, race, and military pay grade. Other significant risk factors (not necessarily independent) for preterm delivery included age less than 20 years, non-Caucasian race, pay grades E1 to E3, less than 2 years military service, a never-married status, and an occupational aptitude score less than 100.

Navy

In a study comparing birth outcome of 100 active-duty Navy women with that of 100 civilian spouses of Navy servicemen, mean birth weight (3,531 ± 0.38 g [7.768 ± 0.845 lb] vs. 3,471 ± 463 g [7.636 ± 1.019 lb]) and gestational age (39.9 vs. 39.8 weeks) were not statistically different between Naval active-duty women and controls (Messersmith-Heroman et al., 1994).

Among active-duty Navy servicewomen (N = 331), rates of cesarean deliveries, transfer for preterm complications, transfer of patients at less than 35 weeks gestation to tertiary care centers, pregnancy-induced hypertension, and intrauterine growth retardation were greater than rates seen among dependent wives of active-duty personnel (N = 1,218) (Magann and Nolan, 1991). Despite access to prenatal care, active-duty women were at higher risk of complications than were military dependent wives. In a subsequent Navy study of 300 consecutive pregnancies of active-duty women, increased maternal age was associated with a significant increase in pregnancy-associated complications of cesarean delivery, operative vaginal delivery, pregnancy-induced hypertension, preterm labor, maternal transport for fetal indications, intrauterine growth retardation, intrauterine fetal death, postpartum hemorrhage, placenta previa, and 5-min Apgar less than 7 (Magann et al., 1995a). In gravidas more than 65 in (1.65 m) in height with gestational weight gain greater than 42 lb (19 kg), there were more complications of pregnancy. Marital status and military occupational specialty (MOS) did not influence pregnancy outcome significantly (Magann et al., 1995b). There were no significant differences in the incidence of medical complications of pregnancy in MOS groups (I = 67%, II = 58%, III = 48%, IV = 53%).

The 1993 *Naval Reproductive Outcome Survey* (Personal communication, S. Hilton, Division of Health Sciences, Naval Health Research Center, San Diego, Calif., 1996) provided preliminary fetal outcome data on 1,170 pregnancies (Table 6-7). The rates of small-for-gestational-age births were 3 percent for Caucasian, 4 percent for African American, and 2 percent for other women. There were no significant differences in gestation duration (37.2 vs. 37.3 weeks), detection of pregnancy (6.5 vs. 6.0 weeks), and gestational weight gain (36.6 vs. 36.2 lb [16.6 vs. 16.4 kg]) in women who were aboard ship until a mean of 18.2 weeks compared with women who were on shore. The proportions diagnosed with pregnancy-induced hypertension were similar in African American and Caucasian women in the Navy and Marine Corps (Irwin et al., 1994).

TABLE 6-7 1995 *Naval Reproductive Outcome Survey*: Fetal Outcome as a Function of Ethnicity

	Livebirth		Fetal Death		Total	
	N	%	*N*	%	*N*	%
Caucasian	653	92	54	8	707	60
African American	300	93	22	7	322	28
Other	134	95	7	5	141	12
Total	1,087	93	83	7	1,170	100

SOURCE: S. Hilton (Personal communication, Division of Health Sciences, Naval Health Research Center, San Diego, Calif., 1996).

Air Force

Despite essentially equal utilization of prenatal care, African American women gave birth to smaller preterm infants than did Caucasian women in the Air Force, even after adjusting for differences in gestational age (Greenberg et al., 1993). Maternal race had little direct effect on the survival of liveborn, preterm infants in this population. Preeclampsia was more frequent in African American women (21 vs. 14%). Nulliparas were at increased risk of pregnancy-induced hypertension (RR = 2.2) compared with parous women, but there was little association with age, race, marital status, or educational level.

Summary

An estimated 9 percent of active-duty women in all service branches are pregnant at any given time (Verdugo, 1996), a figure that, apparently, has varied little over the last 20 years (Hoiberg and White, 1991). Available data suggested that pregnancy rates among active-duty women were lower than those of their age-matched civilian peers (Bray, 1996; Bray et al., 1995; Verdugo, 1996) and that rates drop substantially during deployment. For example, in the first 7 months of Operation Joint Endeavor, 3.4 percent of Army women were evacuated due to pregnancy (Verdugo, 1996).

DoD-wide data on pregnancy complications are not available; studies on pregnancy outcome have been small and do not always distinguish between active-duty women and female military dependents. The percentage of active-duty women receiving prenatal care in the first trimester appears higher than that of civilian women. Active-duty women report a high incidence of pregnancy problems. Only 20 percent of women who participated in a DoD-wide survey reported having had work reassignments due to pregnancy; of these, 80 percent agreed with its necessity although many of these women reported great difficulties with the reassignment. Risk factors for preterm delivery among Army women include heavy on-the-job physical activity, non-Caucasian ethnic origin, military pay grade below Enlisted level 4, age less than 20, unmarried status, and low occupational aptitude test score. Active-duty Navy women also had rates of pregnancy complications that were higher than civilian wives of active-duty personnel. Pregnancy complication rates were not associated with MOS or marital status, but were associated with high gestational weight gain. Studies of pregnancy outcome among active-duty Air Force women have shown that African American women were at increased risk of preeclampsia and of giving birth to smaller preterm infants, but that rates of pregnancy-induced hypertension and infant mortality were unaffected by ethnic origin.

EXERCISE AND PREGNANCY

The American College of Obstetricians and Gynecologists (ACOG) has published guidelines for exercise during pregnancy and the postpartum period (1994). In the absence of obstetric and medical complications, women can engage in moderate levels of physical activity to maintain cardiovascular and muscular fitness throughout pregnancy and the postpartum period. Al-

though maternal sense of well-being may be enhanced, no level of exercise has been shown to improve perinatal outcome. There are no data that indicate deleterious effects of moderate exercise on the fetus, except for findings of lower birthweights among offspring of women who continue to exercise vigorously throughout pregnancy (Clapp and Little, 1995).

The ACOG recommendations are as follows:

1. Pregnant women can continue to exercise and derive benefit from mild-to-moderate exercise routines. Regular exercise (at least three times a week) is better than intermittent activity.
2. Women should avoid exercise in supine position after the first trimester and avoid periods of prolonged, motionless standing.
3. Women should stop exercising when fatigued and not exercise to exhaustion.
4. Avoid exercise that may involve loss of balance and potential for abdominal trauma.
5. Eat an adequate diet to cover the additional needs of pregnancy and exercise.
6. Women who exercise in the first trimester should augment heat dissipation by ensuring adequate hydration, appropriate clothing, and optimal environmental surroundings during exercise.
7. Many of the physiologic and morphologic changes of pregnancy persist 4 to 6 weeks postpartum; therefore, resume prepregnancy routines gradually.

In addition to these guidelines, the ACOG advises that body building or strength training during pregnancy can strengthen muscles and prevent muscle pains that are common during pregnancy. They recommend, however, that strength training be done under expert supervision to help prevent injuries to muscle and joints, using slow, controlled movements and performing sets of no more than 10 repetitions. Research has not been conducted on the benefits or risks of strength training for pregnant women.

A number of obstetric and medical conditions preclude pregnant women from participation in exercise. The following conditions should be considered contraindications to exercise during pregnancy:

- pregnancy-induced hypertension,
- preterm rupture of membranes,
- preterm labor during current or previous pregnancy,
- incompetent cervix/cerclage,
- persistent second or third trimester bleeding, and
- intrauterine growth retardation.

Exercising women should stop exercising if one of the following symptoms occurs: vaginal bleeding, abdominal pain, severe tachycardia, chest pain, severe breathlessness, headache, loss of muscle control, dizziness, or nausea. Consultation with a physician is encouraged.

Lower gestational weight gain and birth weight among women who exercise through pregnancy have been demonstrated in some (Bell et al., 1995; Clapp, 1990; Clapp and Dickstein, 1984; Clapp and Little, 1995) but not all studies (Sternfeld et al., 1995). The effect of endurance exercise on pregnancy outcome was investigated in pregnant women who never exercised,

stopped exercise by the twenty-eighth week of gestation, or continued exercise into the third trimester (Clapp and Dickstein, 1984). Complications of bleeding and premature rupture of membranes contributed to cessation of exercise in some women. Gestational weight gain was significantly lower (26.9 vs. 32.2 lb [12.2 vs. 14.6 kg]), gestational duration was shorter (273.7 vs. 281 days) and birth weight, adjusted for gestational age, was 500 g (17.5 oz) lower in women who exercised into the third trimester. Of 131 well-conditioned, recreational athletes who had an uneventful first half of pregnancy, 87 continued to exercise at 50 percent of preconceptional level throughout pregnancy (Clapp, 1990). Preterm labor was similar in both groups (9%). Exercisers went into labor earlier (277 vs. 282 days), and had fewer cesarean (6 vs. 30%) and vaginal (6 vs. 20%) operative deliveries, and shorter duration of active labor (264 vs. 382 minutes). Birth weight was reduced among the exercisers compared with women who had stopped exercising in the first trimester (117.9 vs. 132.2 oz [3,369 vs. 3,776 g]). Recreational exercise through pregnancy (running, aerobics, cycling, swimming, stairmaster) was associated with decreased gestational weight gain (29 vs. 36 lb [13 vs. 16.3 kg]), diminished subcutaneous fat deposition (0.85 vs. 1.22 in [21.8 vs. 31.3 mm]), and decreased birth weight (115.15 vs. 127.05 g [3,290 vs. 3,630 g]) (Clapp and Little, 1995). In women who exercised vigorously through their third trimester, a dose-dependent reduction in mean birth weight was seen with increasing amounts of weekly exercise (Bell et al., 1995). Birth weight was significantly lower (–11 oz [–315 g]) in women who exercised five to seven times per week than in controls, due primarily to reduced gestational age at delivery rather than fetal growth retardation at term. Incidence of low birth weight infants (< 87.5 oz [< 2,500 g]) was 10 percent in the 58 exercisers compared with 2 percent in the 48 controls. In contrast to the above studies, when four levels of exercise, from vigorous walking at least three times per week for at least 20 minutes to aerobic exercise less than once a week in 388 women, were monitored from 16.5 weeks through delivery (Sternfeld et al., 1995), birth weight, gestational age, and gestational weight gain were unrelated to the level of exercise. Most women substantially decreased exercise during pregnancy.

Active women's enhanced cardiorespiratory responses to acute exercise were maintained during pregnancy if they continued an aerobic fitness program. Pivarnik et al. (1993), Sady et al. (1988), and Lotgering et al. (1991) found that $\dot{V}O_2$max did not change from pregnancy to the postpartum period in subjects of varying fitness levels; however, in studies in which aerobic capacity was assessed prior to pregnancy, $\dot{V}O_2$max was found to be higher during prepregnancy compared with 4 to 8 weeks postpartum in one study (South-Paul et al., 1992), but unchanged at 6 to 8 weeks postpartum, and increased at 12 to 20 weeks postpartum in another study (Clapp and Capeless, 1991).

Fit women who exercise prior to pregnancy may respond differently and may exercise at a higher intensity than sedentary women who wish to adopt an exercise program during pregnancy. Physically conditioned women can perform at a higher exercise power output than sedentary women without inducing fetal hypoxic stress (Webb et al., 1994). Despite higher cycling power output in the exercising versus sedentary group, mean fetal heart rate was similar in both groups. Nevertheless, nearly all women voluntarily decrease the intensity and duration of exercise as pregnancy progresses.

In general, the fetus appears to tolerate maternal exercise well (Clapp et al., 1993). During and after exercise, the fetal heart rate usually increases about 10 to 30 bpm. Fetal bradycardia

has been reported infrequently, usually in the recovery phase of exercise. No adverse effects of the bradycardia were noticed. In another study, decreased fetal movement and breathing were observed after acute exercise (Winn et al., 1994). Because of the difficulties of measuring fetal state, particularly during exercise, and because of the lack of long-term outcome studies, questions remain as to the lasting effects of vigorous exercise on the fetus.

During exercise, elevated core temperatures theoretically could exert a teratogenic effect on the fetus, but maternal adaptations appear to protect it. Peak rectal temperature reached during exercise decreased by 0.3°C at 8 weeks and fell at a rate of 0.1°C/mo through 37 weeks of gestation (Clapp, 1991). Pregnant women without complications can maintain thermal balance during 20 minutes of exercise at 70 percent maximal heart rate on land or water (McMurray et al., 1991).

Although moderate levels of physical activity during pregnancy may be recommended for healthy women without obstetric complications, conservatism is warranted, given the limited number of human studies, small sample sizes, incomplete accounting of subjects who were eliminated because they developed complications, subject self-selection to exercise, difficulties monitoring the fetus during exercise, and inadequate pregnancy outcome data.

Summary

According to ACOG guidelines, in the absence of obstetric and medical complications, women can engage in moderate levels of physical activity to maintain cardiovascular and muscular fitness throughout pregnancy and the postpartum period. No level of exercise has been shown to improve perinatal outcome; lower birthweight has been observed among offspring of women who continue to obtain vigorous exercise throughout pregnancy. Lower gestational weight gain and birth weight among women who exercise during pregnancy has been observed in some but not all studies. There is evidence that aerobic capacity decreases during pregnancy in women of all activity levels, and increases again at 12 to 20 weeks postpartum. Women who were physically active prior to pregnancy can exercise with a greater intensity during pregnancy than previously sedentary women; nevertheless, most physically active women voluntarily decrease the intensity and duration of exercise as pregnancy progresses. Fetal tolerance for maternal exercise appears adequate; maternal adaptations appear to protect the fetus from elevations in maternal core temperature.

POSTPARTUM CHANGES IN WEIGHT AND PHYSICAL FITNESS

No data were found on the percentage of military women who attain weight, body fat, and fitness standards by 6 months postpartum. Gestational weight gain is the major determinant of postpartum weight retention, but unfortunately, representative statistics on gestational weight gain are not available on military servicewomen.

In a prospective study of 105 consecutive deliveries of active-duty women at the Naval Hospital at Pensacola, Florida, mean weight gain of women with complications was 36 lb (16 kg) and without complications 33 lb (15 kg) (Magann et al., 1995a, 1996). Birthweights averaged

114 ± 21.1 oz (3,257 ± 603 g) and 118.3 ± 13.5 oz (3,379 ± 386 g), respectively. The number of women who fell into categories of gestational weight gain less than 25 lb (11.5 kg), 25 to 35 lb (11.5 to 16 kg), and greater than 35 lb (16 kg) was 18, 44, and 43, respectively. Women who gained less than 25 lb (11.5 kg) during pregnancy developed preterm labor more often. In another study, active-duty Navy women gained significantly less (29 vs. 31 lb [13 vs. 14 kg]) than civilian controls ($p < 0.05$) (Messersmith-Heroman et al., 1994). Clearly, more complete information on gestational weight gain is needed on active-duty women in all services.

Gestational Weight Gain

The Institute of Medicine (IOM) recommendations for gestational weight gain have been endorsed by ACOG. Rather than recommending a single figure, the IOM recommends an ideal range, recognizing the natural variability observed in gestational weight gain among healthy, pregnant women (Table 6-8). Because maternal prepregnancy body size modifies the relation between gestational weight gain and birth weight, separate recommendations are made for underweight, normal weight, and overweight women. Very young adolescents and African American women should aim for upper limit of range and short women should aim for the lower limit of range.

Since the release of the IOM recommendations on gestational weight gain, a number of reports have validated the recommendations in terms of infant outcome and postpartum weight retention (Cogswell et al., 1995; Edwards et al., 1996; Hickey et al., 1993; Muscati et al., 1996; Parker and Abrams, 1992; Siega-Riz et al., 1994). A study of 7,000 term births at the University of California, San Francisco, confirmed that compliance with the IOM recommendations was associated with lower risk of delivering small-for-gestational-age or large-for-gestational-age

TABLE 6-8 Recommended Total Weight Gain Ranges for Pregnant Women,* by Prepregnancy Body Mass Index (BMI)†

	Recommended Total Gain	
Weight-for-Height Category	kg	lb
Low (BMI < 19.8)	12.5–18	28–40
Normal (BMI 19.8 to 26.0)	11.5–16	25–35
High‡ (BMI > 26.0 to 29.0)	7–11.5	15–25

* Young adolescents and black women should strive for gains at the upper end of the recommended range. Short women (<157 cm or 62 in) should strive for gains at the lower end of the range.

† BMI is calculated using metric units.

‡ The recommended target weight gain for obese women (BMI > 29.0) is at least 6.0 kg (*sic*) (15 lb).

SOURCE: IOM (1990).

infants, cesarean deliveries, and excessive postpartum weight retention (Parker and Abrams, 1992). For 655 nonobese, multiparous African American women, the risk of fetal growth retardation was 18, 10, and 4 percent for women who gained less than, within, or more than, respectively, the IOM recommendations for their BMI (Hickey et al., 1993). For nonobese Caucasian women, comparable percentages were 20.9, 19.1, and 10.5 percent fetal growth retardation.[1] For 148 obese women, fetal growth restriction occurred in 25 percent of those with a low gestational weight gain compared with 4 percent of those who gained the recommended amount (> 13 lb [> 6 kg]). More women with low BMI gained less than recommended as compared with other groups. Since African American women in each pregravid BMI category delivered increasingly larger infants as they met or exceeded recommended gestational weight gain, it was concluded that African American women should strive for the upper end of the recommended range for pregravid BMI.

To determine the relationship between increased gestational weight gain and birth weight for low-income populations, Caucasian, African American, and Hispanic women (N = 53,541) from eight states were studied between 1990 and 1992 (Cogswell et al., 1995). The risk for low birth weight decreased with increasing gestational weight gain for average-weight women. For very-overweight women (BMI > 29), an upper limit of 25 lb (11.5 kg) was recommended to reduce the risk for high birth weight. In a study comparing 660 normal weight and 683 obese pregnant women, obese women who gained no weight or lost weight were at higher risk for delivery of an infant of birth weight less than 105 oz (3,000 g) or gestational age than were obese women who gained 15 to 25 lb (7–11.5 kg); those who gained more than 35 lb (16 kg) were at twice the risk for delivery of an infant of birth weight greater than 140 oz (4,000 g) (Edwards et al., 1996). To optimize fetal growth, a gestational weight gain of 15 to 25 lb (7–11.5 kg) for obese women and 25 to 35 lb (11.5–16 kg) for normal-weight women appears to be appropriate.

Factors influencing the risk of gaining outside the IOM recommendations for gestational weight gain were investigated in African American (N = 2,617) and Caucasian (N = 1,253) women who delivered at Johns Hopkins Hospital between 1987 and 1989 (Caulfield et al., 1996). The mean gestational weight gain of African American women was 29.3 ± 15.0 lb (13.3 ± 6.8 kg); 38.3 percent gained less and 33.6 percent gained more than recommended. Mean gestational weight gain was greater in Caucasian women (mean = 33.3 ± 12.6 lb [15.1 ± 5.7 kg]) with 24.8 percent gaining less and 43.0 percent gaining more. Factors identified with gaining less were: being younger, shorter, thinner, or less educated; being African American; and a smoker. Factors associated with gaining more were: being taller, heavier, primiparous, Caucasian, and hypertensive. African American women were 1.51 times more likely to undergain and 0.89 times less likely to overgain than Caucasian women.

In the 1988 *National Maternal and Infant Health Survey*, racial differences were larger: 29.1 percent of African American and 36.7 percent of Caucasian women reportedly gained within IOM recommendation (Keppel and Taffel, 1993). Of those gaining outside the recommendations, African American women were 50 percent more likely to undergain, but only 10 percent were less likely to overgain. African American women were more likely to retain at

[1] In this study, the Alabama standards were used; these set fetal growth retardation at higher birth weight for Caucasian than for African American newborns, thus, these percentages are not straight prevalence.

least 20 lb (9 kg) than were Caucasian women (adjusted odds ratio = 2.2) (Parker and Abrams, 1992). African American women were more likely to have inadequate gestational weight gain but not more likely to have excessive gain. Moreover, African American women appear less likely to lose weight postpartum.

Postpartum Weight Loss

Postpartum weight retention increases with gestational weight gain (Abrams, 1994; Parker and Abrams, 1992). Focusing on average postpartum weight retention can obscure subsets of women who retain far more weight. The *National Maternal and Infant Health Survey* (Keppel and Taffel, 1993) showed that median weight retention in Caucasian women 10 to 18 months postpartum was 1.6 lb (0.7 kg), but 30 percent of obese women who gained more than 25 lb (11.5 kg) retained more than 14 lb (6 kg). Postpartum weight retention was higher at every level of prenatal gestational weight gain for African American women. Although high gestational weight gain is associated with more postpartum weight retention, women whose gains are within the recommended IOM ranges (see Table 6-8) are half as likely to retain 20 lb (9 kg) or more than those whose gains are above the upper limit of the range. However, it must be emphasized that only 30 to 40 percent of women gain within the IOM recommendations.

If pregnant women gain weight according to the IOM recommendations and lose approximately 17.31 lb (7.85 kg) at delivery and 1.54 lb/mo (0.7 kg/mo) thereafter, those with low pregravid BMI (< 19.8) would retain 0.9 to 13 lb (0.4–5.9 kg), and women with normal BMI (19.8–26.0) would retain 1.3 to 8.8 lb (0.6–4.0 kg) at 6 months postpartum. In actuality, the majority of pregnant women gain outside of the IOM recommendations, rates of postpartum weight loss are extremely variable, and many women do not attain their prepregnancy weight by 6 months postpartum. Weight changes through pregnancy and the postpartum period are influenced in part by hormonal changes. However, gestational weight gain and postpartum weight loss are amenable to advice, at least on a population basis. Women are encouraged to gain weight within the IOM recommendations during pregnancy and to lose weight postpartum through appropriate nutritional counseling and exercise programs.

In a predominantly Hispanic population (N = 8,736) in Los Angeles, monitoring gestational weight gain revealed that 47.8, 36.6, and 28.4 percent of underweight, normal weight, and overweight women gained within the IOM recommendations (Siega-Riz et al., 1994). Postpartum weight retention was examined in 158 low income women (Parham et al., 1990). The mean gestational weight gain was 28.4 ± 12.8 lb (12.9 ± 5.8 kg), with 44 percent gaining more than 30 lb (13.6 kg) and 25 percent gaining less than 20 lb (9.1 kg). According to the gestational weight gain tertiles, postpartum weight retention 6 to 9 months later was 6.6, 7.1, and 13.4 lb (3.0, 3.2, and 6.1 kg) for the lower (gestational weight gain = 15.2 lb [6.9 kg]), middle (28 lb [12.7 kg]), and upper (42.5 [19.3 kg]) tertiles, respectively.

In 371 Canadian women with uncomplicated pregnancies, gestational weight gain averaged 35.5 ± 14.1 lb (16.1 ± 6.4 kg) (fifteenth to eighty-fifth percentiles, 23 to 49.8 lb [10.4 to 22.6 kg]) (Muscati et al., 1996). Postpartum weight retention at 6 weeks postpartum equaled 11.7 ± 12.6 lb (5.3 ± 5.7 kg) (fifteenth to eighty-fifth percentiles, –18.1 to 61.1 lb [–8.2 to 27.7 kg]); approximately 75 percent retained greater than 2.5 kg. In a large cohort of Swedish women (N =

1,423), at 1 year postpartum, net gain was 3.3 ± 7.9 lb (1.5 ± 3.6 kg); 30 percent had lost weight, 56 percent had gained 0 to 11 lb (0–5 kg), and 14 percent had gained more than 11 lb (5 kg) (Öhlin and Rössner, 1990).

Predictors of postpartum weight loss included ethnicity, gestational weight gain, prepregnancy weight, parity, and prenatal exercise (Boardley et al., 1995; Schauberger et al., 1992). Weight retained by African American women was 6.4 lb (2.9 kg) more than that by Caucasian women (Boardley et al., 1995). African American women had higher energy intake, higher percentage dietary fat, and lower prenatal and postnatal activity. In a study of predominantly Caucasian women (N = 795), the average weight retention at 6 months postpartum was 3.1 lb (1.4 kg); 37 percent of women had returned to their prepregnancy weight (Schauberger et al., 1992).

Although lactation unquestionably creates an energy deficit for women, several other overriding factors appear to determine postpartum weight change. Changes in body weight and composition in response to lactation are highly variable among individuals. Mean rates of weight loss across studies of lactating women range from –0.95 to –1.98 lb/mo (–0.43 to –0.90 kg/mo) in the first 6 months postpartum (Butte et al., 1984; Dewey et al., 1993; Manning-Dalton and Allen, 1983; Naismith and Ritchie, 1975; Sohlström and Forsum, 1995). However, studies comparing postpartum weight changes in lactating and nonlactating women are not unequivocal; most indicated comparable rates of weight loss between feeding groups. Of the factors associated with postpartum weight change, gestational weight gain is by far the most consistent and strongest predictor across all studies.

Average postpartum weight changes conceal the extreme variability among women (Lederman, 1993). In addition to gestational weight gain, parity, age, and ethnicity have all been shown to influence postpartum weight change. While most women approach their prepregnancy weight by 6 months, subsets of women retain substantial weight.

Use of Military Body Composition Equations in Postpartum Women

The use of standard military equations for estimation of body fat at return-to-duty testing has not been validated in postpartum women. Fat is deposited preferentially at certain body sites during pregnancy, which may bias body fat estimates. For instance, the Army and Navy equations may overestimate body fat, since these equations use hip circumference, a predominant site of fat deposition. The study of Westphal and coworkers (1995) on women in BCT found no differences in average body fat or fat deposition between nulliparous women and those who had given birth. However, length of time since delivery was not considered.

Changes in Postpartum Physical Fitness

In a study by Carpenter et al. (1990), absolute rates of $\dot{V}O_2max$ (liters/min) on the cycle and treadmill fell postpartum, but when these rates are expressed as a function of body weight (liters/kg/min), there was no significant reduction. In recreational athletes, the exercise duration-intensity index decreased 30 to 45 percent during pregnancy, mainly due to decreased intensity; a further 20 percent decrease was observed initially postpartum (Clapp and Capeless, 1991). By 12

weeks postpartum, the duration-intensity index was 20 percent less than the preconceptional level and remained there; the decrease was due to duration. A significant 7.3 percent increase in absolute $\dot{V}O_2$max was evident 12 to 20 weeks postpartum and was maintained at the time of final testing 36 to 44 weeks postpartum. These data indicate that there is a small but significant postpartum increase in $\dot{V}O_2$max in recreational athletes who maintain a moderate-to-high level of exercise performance during and after pregnancy, possibly due to the training effect of increased physical work daily. In nine women, cycle ergometry was done at 26 weeks of pregnancy and 2 and 7 months postpartum (Sady et al., 1990). Antepartum resting cardiac output, heart rate, and stroke volume were higher, and arteriovenous difference was lower, than postpartum. No significant differences were seen in $\dot{V}O_2$max or heart rate among the three time periods.

Summary

Gestational weight gain is the primary determinant of postpartum weight retention. Data on gestational weight gain and postpartum weight loss are not available for a representative sample of active duty women.

Birth weight increases with increasing gestational weight gain. The IOM has published recommended ranges of gestational weight gain to optimize fetal growth, based on pregravid BMI, age, and ethnicity. These recommendations have been endorsed by several other groups and validated with respect to infant outcome. Many women gain outside of the recommended ranges. Factors associated with low gestational weight gain include young age, short stature, low body weight, lower educational achievement, smoking, and African American ethnic origin.

Postpartum weight retention is highly variable, depending in part on gestational weight gain, hormonal levels, parity, age, ethnicity, decision to breastfeed, and other lifestyle factors. gestational weight gain within ranges recommended by IOM is associated with less risk of high postpartum weight retention. A subset of women, obese women with gestational weight gain of more than 25 lb (11.5 kg), appears to retain significantly more weight than average. Postpartum weight retention is higher at every level of gestational weight gain for African American women. Many women do not return to prepregnancy weight by 6 months postpartum. The use of military equations for anthropometric estimation of body fat at return to duty has not been validated.

Results of a small number of studies indicate that there is a small but significant postpartum increase in maximal aerobic capacity in women who maintain a moderate-to-high level of exercise performance during and after pregnancy.

LACTATION

Breastfeeding is recommended as the preferred method of infant nutrition by the American Academy of Pediatrics, American College of Obstetricians and Gynecologists, and American Academy of Family Physicians. The recommendation to breastfeed arises from its acknowledged benefits with respect to infant nutrition, gastrointestinal function, host defense, and psychological well-being, as well as to maternal health. The protective effects of breastfeeding have been shown to reduce infant morbidity and associated health care costs. The *Healthy People 2000*

goals aim for breastfeeding prevalence of 75 percent at birth and 50 percent at 5 to 6 months postpartum (DHHS, 1991).

Military Studies

With a few exceptions, no data could be located on the prevalence and duration of breastfeeding among military women (Louder and Yoder, 1997; Personal communication, S. Hilton, Division of Health Sciences, Naval Health Research Center, San Diego, Calif., 1996). The 1993 *Naval Reproductive Outcome Survey* (N = 1,070) indicated a breastfeeding duration of less than 1 month in 18 percent of subjects, 1 to 2 months in 16 percent, 2 to 3 months in 10 percent, greater than 3 months in 21 percent, and 35 percent did not breastfeed at all (Personal communication, S. Hilton, Division of Health Sciences, Naval Health Research Center, San Diego, Calif., 1996). At Lackland AFB, 1,138 deliveries were monitored over a 10-mo period. Of the respondents, 70 percent intended to breastfeed, 24 percent intended to use formula, and the remainder were planning to do both. Women who intended to feed formula had lower educational attainment, shorter pregnancies, later first obstetric appointment, lower sponsor's military rank (junior enlisted to senior officers), less likelihood of being married, and different sponsor's military status (sponsor refers to the responsible individual—self, spouse, or parent—who is on active duty or who is retired from the military). Maternal ethnicity influenced the intent to breastfeed, with African American mothers having the lowest intention rates. At discharge, the actual feeding mode was described as: 47 percent breastfeeding, 12.5 percent mostly breastfeeding, 7 percent doing both, 3.5 percent mostly feeding formula, and 30.3 percent solely feeding formula. No studies could be identified that addressed the impact or potential impact of breastfeeding on readiness.

Lactation and Postpartum Weight Loss

Research on the rate of weight loss during lactation (IOM, 1991) tends to show an average weight loss between 0 and 6 months postpartum of 1.3 to 1.8 lb/mo (0.6–0.8 kg/mo) and between 6 and 12 months postpartum of approximately 0.2 to 0.4 lb/mo (0.1–0.2 kg/mo). However, the rate of weight loss actually shows wide variation among women. Notably, a proportion of women gain weight during lactation (Butte et al., 1984; Manning-Dalton and Allen, 1983). The women with the largest net gestational weight gain tended to lose the most weight postpartum (Manning-Dalton and Allen, 1983). Rates of change in body weight, body fat, and skinfold thickness were not correlated with parameters of lactation performance in the first 4 months of lactation (Butte et al., 1984). However, maternal weight change was significantly correlated with the protein concentration in milk at 6 and 9 months, and with the lipid concentration at 6 months (Nommsen et al., 1991). The amount of energy mobilized from tissue reserves is relatively minor compared with that from dietary sources. The compensatory interaction between dietary energy and tissue mobilization may protect milk synthesis in well-nourished women. As lactation advances and tissue reserves diminish, milk production may be influenced by maternal nutritional status.

Öhlin and Rössner (1990) monitored weight change in 1,423 Swedish women for 12 months postpartum and found a highly significant correlation between gestational weight gain and weight retention postpartum. Weight loss between 2.5 and 6 months postpartum was significantly higher in women who breastfed exclusively. However, total weight loss between 2.5 and 12 months was not significantly influenced by the duration or intensity of lactation. Changes in weight and skinfold thicknesses were monitored in 151 Irish women for 12 months postpartum (Dugdale and Eaton-Evans, 1989). A pattern of weight loss was seen in the first 6 months, after which weight plateaued. Changes in weight were independent of the duration of breastfeeding, but were influenced by the initial BMI and the desire to lose weight.

There is no evidence that weight loss up to 4 lb/mo (2 kg/mo) has adverse effects on lactation in well-nourished women. Effects of rapid weight loss are unknown, particularly during the first month postpartum when the milk supply is being established.

Physical Activity and Lactation

No adverse effect of vigorous exercise on lactation performance was observed in a group of exercising women ($N = 8$) compared with sedentary women ($N = 8$) (Lovelady et al., 1990). The effects of an exercise program on lactation performance were studied in a randomized intervention trial (Dewey et al., 1994). The experimental group engaged in aerobic exercise 45 min/d, 5 d/wk for 12 weeks; and the control group exercised vigorously no more than once per week. An increase in aerobic capacity was seen in the exercising group, but there was no difference in weight loss or body composition, because they consumed more food. No adverse effects on lactation performance or infant weight gain were observed in the exercising group. Women who breastfeed can undertake exercise without jeopardizing milk volume or composition. One report cited a transitory increase in lactic acid in breast milk following exercise, but this did not affect intake as taste is apparently not a problem with most infants (Wallace et al., 1992).

Summary

Numerous physicians' organizations recommend breastfeeding as the preferred method of infant feeding because of its benefits with respect to infant nutrition, gastrointestinal function, host defense, and psychological well-being, as well as its protective effect on maternal health. Except for small studies, no data are available on the prevalence or duration of breastfeeding among active-duty military women. Among a group of Air Force active-duty women and dependents, intention to breastfeed was associated with higher educational attainment, longer pregnancies, earlier first obstetric appointment, higher rank or sponsor rank, marital status, and Caucasian ethnic origin. At hospital discharge, prevalence of women actually breastfeeding (47%) was significantly lower than intention to breastfeed had been (70%).

In studies of civilian women, vigorous physical activity and exercise does not appear to affect lactation performance.

NUTRITION DURING PREGNANCY AND POSTPARTUM

A complete guide for nutritional counseling of pregnant and lactating women is available (IOM, 1992). For all pregnant women, a daily supplement of 30 mg of ferrous iron is recommended during the second and third trimesters. The U.S. Public Health Service recommends that all women of childbearing age should consume 400 μg/d of dietary folate for the purpose of reducing their risk of having an infant affected with spina bifida or other neural tube defects (CDC, 1992). The IOM (1998) recommends that an intake of 600 μg/d dietary folate[2] be consumed during pregnancy and that 500 μg/d be consumed during lactation. During pregnancy and lactation, women should abstain from smoking. Alcohol should be avoided during pregnancy and should only be consumed in moderation during lactation (IOM, 1990).

In the postpartum period, persistent anemia and musculoskeletal and cardiovascular changes present potential problems for the mother. Women with low iron stores before pregnancy could require 5 to 6 months to recover from iron deficiency and another 4 months or more to replete iron stores. Back pain and injury remain as significant risks in the postpartum period and can be countered by a program of strengthening and stretching exercises for the abdomen, back, and legs.

CONCLUDING REMARKS

Pregnancy is compatible with a military career. It represents a short period in a woman's military career and can be accommodated with planning. The rate of pregnancy among active-duty women is lower than that of civilian women of comparable ages; however, given the high rates of unplanned pregnancies among military women, there appears to be a need for education and counseling for all servicemembers on effective birth control and the importance of timing a pregnancy in one's military career. To reduce attrition and enhance military readiness, all supervisory staff need increased training and education regarding pregnancy policy and treatment of pregnant personnel.

Few data are available on pregnancy outcome or the rate of gestational weight gain and postpartum weight loss for active-duty women. The limited data available suggest that pregnancy complications are higher among active-duty women than among civilian women and that active-duty women may tend to seek prenatal care later than their civilian counterparts (however, there are conflicting data regarding this latter point). A 1992 report of the IOM established guidelines for recommended gestational weight gain, which have been endorsed by the ACOG. Many women do not gain within the recommendations. Gestational weight gain is one factor responsible for rate of postpartum weight loss. The use of standard military equations for estimation of body fat at return-to-duty testing has not been validated in postpartum women. If the equations contain waist and hip measurements, they may penalize women unfairly during the child-bearing years.

The ACOG has published guidelines for exercise during pregnancy and the postpartum period (1994). In the absence of obstetric and medical complications, pregnant women can engage in moderate levels of physical activity to maintain cardiovascular and muscular fitness

[2] As dietary folate equivalents (DFEs). 1 DFE = 1 μg food folate = 0.6 μg of folic acid (from fortified food or supplement) consumed with food = 0.5 μg of synthetic (supplemental) folic acid taken on an empty stomach (IOM, 1998).

throughout pregnancy and the postpartum period. Although maternal sense of well-being may be enhanced with exercise, no level of exercise has been shown to improve perinatal outcome. Except for findings of lower birthweights among offspring of women who continue to exercise vigorously throughout pregnancy, no data indicate deleterious effects of moderate exercise on the fetus. Intent and participation in exercise should be reviewed with the guidance of the woman's obstetrician.

Breastfeeding is recommended as the preferred method of infant nutrition by the American Academy of Pediatrics, American College of Obstetricians and Gynecologists, and the American Academy of Family Physicians. The prevalence and duration of breastfeeding by military women is virtually unknown.

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7

Conclusions and Recommendations

After reviewing the relevant literature and current military policies, the Committee on Body Composition, Nutrition, and Health (BCNH committee) provides the following conclusions and recommendations in response to the questions posed by the military. Recommendations for future research are provided following the responses to the questions.

What body composition standards best serve military women's health and fitness, with respect to minimum lean body mass, maximum body fat, and site specificity of fat deposition? Are the appearance goals of the military in conflict with military readiness?

At the present time, a two-tiered assessment procedure is employed by the military to assess body composition. The first tier consists of a weight-for-height determination using service-specific tables. Personnel deemed overweight are subjected to a second tier of screening consisting of body fat assessment by service-specific circumferential equations that have been validated against the method of underwater weighing. While the Department of Defense (DoD) maximum body fat for women is 36 percent, each service sets its own (lower) standards; thus personnel who are out of compliance in their own service, may be within the standards of another service. Agreement is poor among the body composition assessments provided by each of the equations for the same individuals (that is, assessment of an individual women's percent body fat using

each of the three service-specific equations results in three different values). In addition, validation of the equations has been called into question because the population used diverges significantly in ethnic profile from that of today's military. Personnel who fail the body fat screening within their service are referred to a weight management program, with consequences for their careers.

Fitness is assessed by the military coincident with, but independent of, body composition. Data suggest that a significant percentage of younger personnel cannot pass the fitness tests. These tests assess aerobic capacity and in some cases endurance, but they do not correlate well with performance on tasks requiring strength (characteristic of a high percentage of military operational specialties). Efforts to show a relationship between body composition and fitness among military women have reached the conclusion that women who are judged to be out of standard with respect to body fat perform better on tests of strength than women who are within the body fat standards. Thus, the current body composition assessment procedures may select against retention of those who may be most capable of performing the tasks necessary for military operations while selecting in favor of those who fit an appearance standard.

Recommendations

• The BCNH committee recommends the revision of the two-tiered body composition and fitness screen to that presented in Figure 7-1.

The first tier should consist of semiannual assessment of body mass index (BMI, weight in kilograms divided by the square of the height in meters) and fitness (including strength and endurance). The acceptable range of BMIs, based on considerations of health and chronic disease risk, is recommended to be 19 to 25,[1] independent of age. Individuals whose BMI falls within the desirable range and who pass the fitness test need no further screening. Individuals with BMIs greater than 25 should be subjected to a second tier of screening, based on body fat assessment. The committee believes that women with BMIs less than 19 can be fit to perform. However, as BMI decreases below 19, women may be at risk for malnutrition and should be considered for medical evaluation.

Individuals whose body fat is assessed at 36 percent or less and who pass the fitness test will be considered within standard. Individuals whose body fat exceeds 30 percent and who fail the fitness test will be referred to weight management and fitness programs. Individuals whose body fat exceeds 36 percent will be referred to a weight management program, regardless of fitness score.

• The BCNH committee also recommends the development of a single, service-wide, circumferential equation for assessment of women's body fat, to be validated against a four-compartment model using a population of active-duty women or a population that is identical in

[1] Table S-3 in the Executive Summary shows the BMIs corresponding to current Army weight limits for women. Table S-4 shows the weight ranges that correspond to the recommended BMI range of 19 to 25.

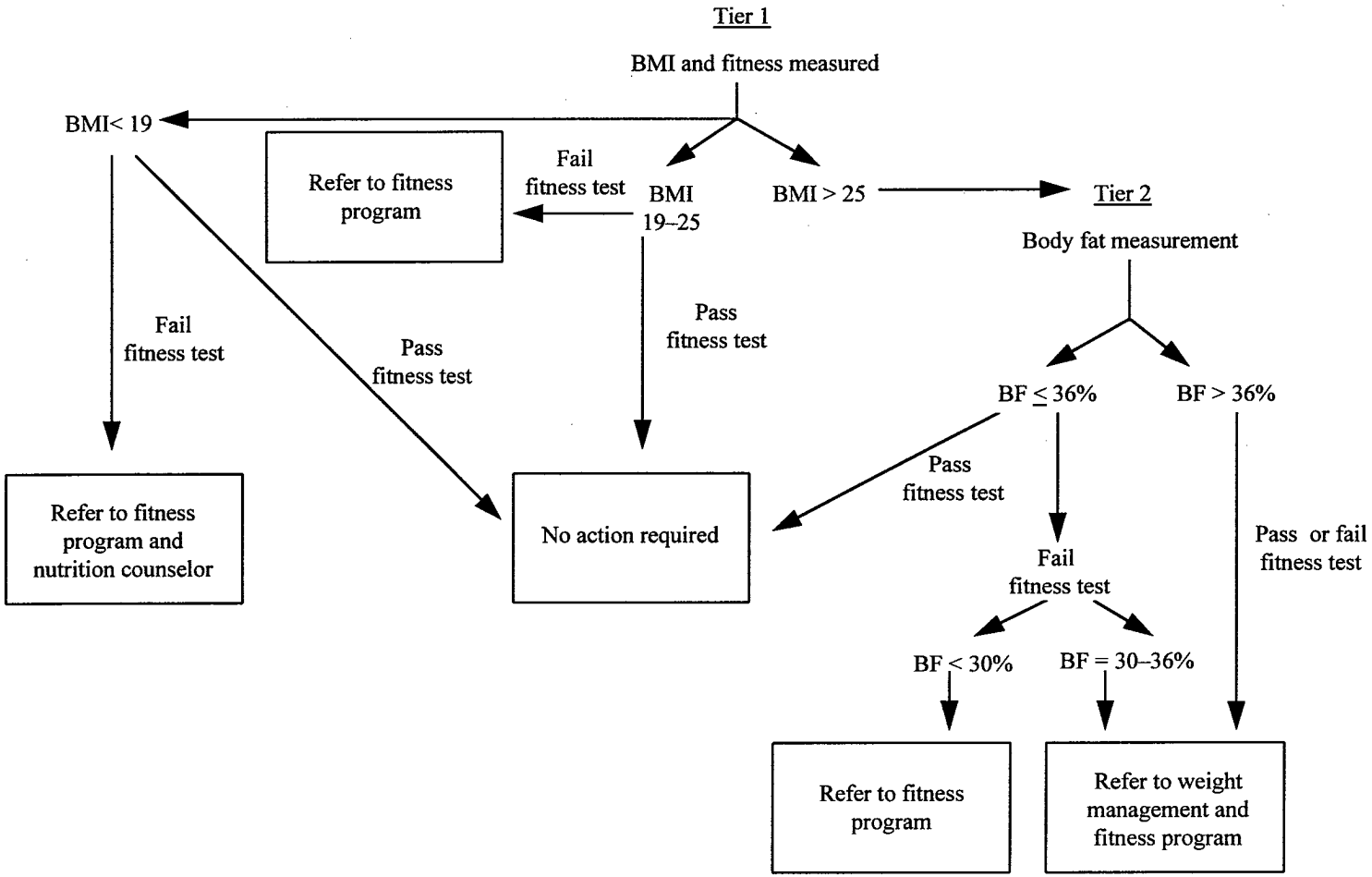


FIGURE 7-1 Revised flow chart for screening recommendation. BMI, body mass index; BF, body fat.

ethnic and age diversity to that of military women. Development and validation of this equation may result in the reconsideration of the recommended BMI cut-offs, in part as a result of establishing the measurement error.

- The BCNH committee recommends increasing emphasis on the importance of general fitness for health and readiness by enforcing uniformly across all services and military occupational specialties (MOSs) regular and monitored participation in a fitness program consisting of a minimum of 3 d/wk of endurance exercise at 60 to 80 percent of maximum capacity for 20 to 60 minutes and 2 d/wk of resistance exercise using all major muscle groups at 85 percent of 1 repetition maximum (ACSM, 1990). Such a program, in addition to promoting fitness, assists in maintenance of weight and fat-free mass (FFM). Periodic fitness and body composition testing, adjusted appropriately for gender, would be conducted to determine both endurance and strength and would be similar across all services. More frequent testing would promote continuous adherence to weight and physical fitness programs and decrease injurious behaviors that result from efforts to pass performance and body composition tests.
- The committee further recommends the development of task-specific, gender-neutral strength and endurance tests and standards for use in the determination of placement in military occupational specialties that require moderate and heavy lifting. Additional fitness programs should be created and enforced to develop and maintain the strength, endurance, and flexibility required by these MOSs.
- The BCNH committee recommends that, in view of the association between FFM (as an indirect indicator of skeletal muscle mass) and strength, the military consider developing an appropriate minimum recommended BMI for accession of women.
- The current appearance standard does not appear to be linked to performance, fitness, nutrition, or health. The BCNH committee recommends that if the military deems appearance standards to be necessary, objective criteria (that do not discriminate on the basis of ethnicity) should be developed and utilized.

Discussion

The substitution of BMI for existing weight/height screening tables is recommended based on mounting evidence of clear associations between BMI, fitness, and health. Body composition estimates for military personnel should supplement BMI-based measures as an additional means of evaluating the health and fitness components of military readiness. Body composition estimates of potential importance to readiness include skeletal muscle, total fat, FFM, and fat distribution. The body composition prediction model should employ an equation based on measured circumferences and other relevant independent variables such as ethnicity. This equation must be service wide and must be validated against measurements performed using multicompartment models and a population matched to the gender, ethnic, vocational, and age heterogeneity present among women throughout the military.

Fitness testing must include an evaluation of cardiorespiratory endurance, strength, muscular endurance, and flexibility. Suggested guidelines include those prepared by the American College of Sports Medicine (ACSM, 1990). There must be an increase in the emphasis placed on

regular physical activity as a means of increasing fitness, endurance and strength; managing weight; and reducing risk of musculoskeletal injury.

Recommendations for Additional Research

Additional research is needed to refine and standardize anthropometric equations for body fat prediction and to validate them against current four-compartment models. This research must be conducted with a population that is representative of active-duty women with respect to ethnic and age diversity.

In view of the relationship between skeletal muscle/FFM and strength, and recent developments in the ability to assess these parameters, research is recommended to develop an expedient method for the prediction of FFM using anthropometric measurements.

It is also recommended that programs designed to increase strength as well as those seeking to redesign certain tasks be pursued along with the development and validation of task-specific, gender-neutral strength tests for use in determining placement in military occupational specialties requiring moderate and heavy lifting. Task-specific training tests have been developed and validated for comparable jobs in the civilian sector. General and task-specific strength training should be incorporated into basic combat training, advanced training, and ongoing fitness programs to ensure that the maximum strength level requirements of each individual's MOS can be met.

Further research is recommended on the incidence and risk factors for stress fracture and other musculoskeletal injuries in active-duty women.

Should any part of the Military Recommended Dietary Allowances (MRDAs) be further adjusted for women? Should there be any intervention for active-duty women with respect to food provided, dietary supplementation, or education?

In view of current ongoing efforts by the Food and Nutrition Board to revise the Recommended Dietary Allowances upon which the MRDAs (AR 40-25, 1985) are based, the BCNH committee advises that revision of the MRDAs be deferred to a later time, and it has chosen to concentrate on several nutritional issues of importance to active-duty women.

While the MRDAs for calcium, folate, and iron appear to be adequate within normal balanced diet plans, that is, when full rations are consumed (3,600 kcal/d), the average woman cannot consume the equivalent of full rations. Moreover, she may not be able to consume the quantity of energy upon which the MRDAs are based, if she is to balance energy intake with expenditure.

Outcome data for the military weight management programs are currently unavailable. In addition, it is not possible at the present time to determine how individual sites administer their programs. Nevertheless, comparison of the programs as described in the regulations governing these programs with recent recommendations regarding methods for long-term weight loss and management suggest a number of disparities. In addition, evidence from self-report surveys sug-

gests that a significant percentage of military personnel may engage repeatedly in high-risk behaviors to comply with periodic weight and body composition assessments.

Recommendations

- The BCNH committee reinforces the requirement for adequate energy and nutrient intakes to reflect the needs of the body at a moderate activity level (2,000–2,800 kcal/d). To ensure adequate nutrient intakes, female personnel must be educated on how to meet both energy and nutrient needs whether they are deployed and subsisting on operational rations or in garrison. This education is required to enable women to choose foods of higher nutrient density and to maintain a fitness program that will allow greater energy intake. The committee reinforces the recent efforts of the Army to begin providing complete nutritional labeling of all ration components and to include information to enable identification of nutrient-dense components that would help women meet the MRDAs at their usual energy intake. The committee also supports efforts to create ration supplements that would satisfy requirements that may not be readily met through the usual intake of rations. The committee recommends nutritional labeling of all dining hall menu items and provision of food selection guidelines to women in garrison.
- The BCNH committee recommends that all military women maintain or achieve healthy weight through a continuous exercise and fitness program. If weight loss is a goal, nutrition education and ongoing counseling should be provided for guidance in achieving a healthy, but reduced energy, diet. Emphasis must be placed on prevention of overweight and on long-term weight management through lifestyle changes, rather than on crash dieting to lose weight for a scheduled weigh-in. Adequate energy intake should be encouraged to reduce risks of injury and amenorrhea.
- In view of observed dehydration-induced changes in physiology resulting in performance decrements, and because of evidence that active-duty women in deployment situations may voluntarily restrict fluid intake, adequate intake of fluids must be emphasized (IOM, 1993, 1995). Adoption of the Army fluid doctrine is encouraged by all services.

Discussion

Assessments of nutritional status and dietary intake of active-duty women have been limited to studies of women in basic combat training or on brief field maneuvers. Nevertheless, the results of these studies strongly suggest that because of the nutrient density of operational rations and dining hall menus, active-duty women are at risk for inadequate intake of several nutrients, particularly iron, calcium, and folate, if their energy intake matches expenditure. Education should be aimed at meeting requirements for these nutrients as well as for protein, by helping women to identify and select appropriate foods. Available evidence suggests that the energy needs of the average active-duty woman should reflect a moderate activity level. To ensure adequate energy and nutrient intake, some modifications of operational rations may be needed to increase the nutrient density. Alternatively, use of supplements for iron, calcium, and folate should be considered.

While it appears that military weight management programs thus far have not been required to perform rigorous measurement of outcome, their design suggests a lack of follow-up and inadequate emphasis on techniques for long-term weight management. Such techniques include ongoing education and counseling and programs to support regular physical fitness and other lifestyle changes. Nutrition education must emphasize changing dietary habits by selection of lower fat foods, understanding of portion sizes, and decreasing consumption of alcohol. A basic understanding of obesity prevention, nutrition, and fitness knowledge should be imparted to all military personnel with emphasis on doable measures and skill building, rather than just cognitive knowledge.

Recommendations for Additional Research

Additional research is needed on the effects of environmental stressors on the nutritional status and needs of active-duty women. It is recommended that the military coordinate its research efforts in this area with those of the civilian sector.

What special guidance should be offered with respect to return-to-duty standards and nutrition for women who are pregnant or breastfeeding?

At the present time, active-duty women who become pregnant are exempt from compliance with body composition standards and fitness testing until 6 months postpartum. Restriction on the types of duty that pregnant soldiers may perform differs with branch of service and usual work environment. While it is known that many active-duty women who become pregnant are exposed to a variety of environmental extremes prior to transfer to lighter duty, data are extremely limited regarding nutrient status, physical fitness, and pregnancy outcomes in the active-duty population. In the absence of additional pertinent data, the committee makes the following recommendations.

Recommendations

- The BCNH committee recommends that all women be encouraged to eat an adequate diet during pregnancy and lactation as recommended by the Institute of Medicine (IOM, 1990, 1991). The committee further recommends an intake of 400 μg/d dietary folate during childbearing years, 600 μg/d during pregnancy and 500 μg/d during lactation as recommended by the IOM (1998). A daily supplement of 30 mg of ferrous iron (IOM, 1990) is recommended during the second and third trimesters of pregnancy. During pregnancy and lactation, women should abstain from smoking. Alcohol should be avoided during pregnancy and should only be consumed in moderation during lactation (IOM, 1990).
- The BCNH committee recommends that pregnant women without obstetrical or medical complications engage in moderate levels of physical activity to maintain cardiovascular and muscular fitness throughout the pregnancy and the postpartum period. The American College of Obstetricians and Gynecologists (ACOG, 1994) has published guidelines that should be used to

advise pregnant active-duty women to modify their physical fitness program. Programs should be individualized and made available to healthy women who can and wish to exercise.

- The BCNH committee recommends the endorsement of the IOM guidelines for gestational weight gain as outlined in Chapter 6 and Table 6-8. Women should be encouraged to gain within the IOM recommendations during pregnancy and to lose weight postpartum through appropriate nutritional counseling and exercise programs. The BCNH committee recommends that the proposed time allowance for compliance to weight and body fat standards postpartum be consistent with IOM recommendations for gestational weight gain. When satisfactory progress is being made towards compliance, an allowance of up to 1 year postpartum should be given for attainment of body weight standards.
- Resumption of exercise postpartum will depend on the type of delivery and the postpartum state of the woman and should be left to the discretion of the woman's obstetrician. Once clearance is given by the woman's physician to resume exercise, a time allowance of 180 days should be sufficient to meet physical fitness standards.
- The *Healthy People 2000* (DHHS, 1991) goal for breastfeeding specifies that at least 75 percent of women should breastfeed their babies in the early postnatal period and 50 percent of women should continue to breastfeed until their babies are 5 to 6 months old. As the military has provided no indication as to why they should not strive to comply with this goal, the committee recommends that efforts be made to promote and support breastfeeding among all servicewomen, where appropriate. Promotion of breastfeeding can be incorporated into prenatal classes, family support classes, hospital policies, and training of health care providers.
- The BCNH committee calls attention to the persistent anemia and musculoskeletal and cardiovascular changes that may continue in some women postpartum. These changes may present potential health problems for the mother and compromise her fitness status. Women with low iron stores before pregnancy or excessive blood losses at delivery may require an extended period (5–10 months) to replete/normalize stores. Achievement of normal iron stores prior to and during pregnancy and prevention or correction of anemia may require the use of supplemental iron.
- An increase in the length of exemption from deployment from 4 to 6 months postpartum is recommended to support maternal postpartum recovery, breastfeeding, and enhanced infant health and development.

The BCNH committee acknowledges that childbearing is compatible with a military career. Planning and education on effective birth control and counseling on the importance of timing pregnancy in one's military career should be provided to all servicemembers. The committee also recommends training and education for all supervisory personnel regarding pregnancy policy, as well as a prenatal counseling program for pregnant active-duty women. These policies should be implemented to reduce attrition and enhance military readiness.

Discussion

The IOM recommendations for gestational weight gain have been endorsed by the ACOG and should likewise be endorsed by the DoD. Rather than a single figure, a desirable range is recommended, recognizing the natural variability observed in gestational weight gain among

healthy, pregnant women. Because maternal prepregnancy body size modifies the relation between gestational weight gain and birth weight, separate recommendations are made for underweight, normal-weight, and overweight women. Very young adolescents and African American women should aim for the upper limit of the range, and short women should aim for the lower limit of the range. In adopting the gestational weight gain recommendations, routine monitoring of gestational weight gain and medical/nutritional counseling for inadequate or excessive gestational weight gain should be implemented. There is a lack of representative data on the gestational weight gain of military women. Systematic recording of gestational weight gain and pregnancy outcome among military women would serve to identify and target vulnerable groups or hazardous occupational exposures.

As recommended by the ACOG (1994), in the absence of obstetric and medical complications, pregnant women can engage in moderate levels of physical activity to maintain cardiovascular and muscular fitness throughout the pregnancy and the postpartum period. Although the maternal sense of well-being may be enhanced, no level of exercise has been shown to improve perinatal outcome. Except for findings of lower birthweights among offspring of women who continue to exercise vigorously throughout pregnancy, no data indicate deleterious effects of moderate exercise on the fetus. Intent and participation in exercise should be reviewed with the guidance of the woman's obstetrician. Programs for exercise during pregnancy cannot be mandatory, but they should be made available to healthy gravid women who can and wish to exercise. Programs should be individualized and women allowed to exercise at their own pace. Fit women who exercised prior to pregnancy may respond differently and may exercise at a higher intensity than sedentary women who wish to adopt a moderate exercise program during pregnancy. Nearly all women voluntarily decrease the intensity and duration of exercise as pregnancy progresses.

The prevalence and duration of breastfeeding by military women are virtually unknown. Efforts should be made to promote and support breastfeeding among all servicewomen, where appropriate with regard to the individual. Promotion of breastfeeding can be incorporated into prenatal classes, family support classes, hospital policies, and training of health care providers. Access to consultants on breastfeeding and a private room to express milk once back at the work site would support the continuation of breastfeeding. Exemption from deployment for 6 months postpartum is recommended to support maternal postpartum recovery and breastfeeding. Attainment of military weight standards by 6 months postpartum may be unrealistic for some individuals and restrictive for women who desire to breastfeed, in that drastic weight reduction may compromise milk production.

Recommendations for Additional Research

The use of standard military equations in postpartum women for estimating body fat at return-to-duty testing has not been validated. Therefore, the BCNH committee recommends that validation studies be conducted in these women, controlling for ethnicity, age, and parity.

RECOMMENDATIONS FOR FUTURE DESIGN AND ADMINISTRATION OF SURVEYS

It is clear that the military services do not collect and archive all of the information needed to clearly define the positive and negative consequences of their body fat and fitness standards for military women. Data as simple as the height and weight of each servicemember are not centrally archived in automated information systems and thus are unavailable to analysts and policymakers. The shortfall is particularly serious regarding information on pregnant women. As a result, it is not possible to assess systematically what military women do to meet weight and fitness standards, how effective their behaviors are, or what the long-term health consequences of the behaviors are. To do this requires a DoD-wide evaluation system.

Relevant Data from Previous Surveys of Military Personnel

Several research projects have been conducted by the services on the health-related behaviors of servicemembers. A list of the most recently administered relevant surveys is provided in Table 7-1.

Relevant Data in Existing DoD Databases

In addition to the wide variety of demographic and personnel data maintained in the Defense Manpower Data Center database, health outcome data are maintained in several medical cost accounting databases. A list of the databases that contain pertinent information is provided in Table 7-2.

Effective Use of Existing Data

A combination of the survey instruments that have been used in the past would be suitable for collecting most of the information needed (including longitudinal data). The personnel and medical databases are capable of producing much of the remaining information needed. However, the committee finds that there are two problems with this method of data collection. First, some of the survey data were collected anonymously (with no identification numbers of any type), precluding any attempt to examine the data longitudinally or merge the databases with existing personnel and medical databases that contain the demographic and health outcome data needed for a comprehensive analysis of the data. Second, the personnel and medical databases were not designed to be linked to each other or to survey databases. Thus, although much potentially worthwhile information has been collected, little meaningful analysis can be performed.

TABLE 7-1 Military Surveys of Health Behaviors

Reference	Name	Description
Bray et al., 1995	*Survey of Health-Related Behaviors among Military Personnel* (SHRBAMP)	Triennial survey that sampled all active-duty personnel using a stratified random sampling strategy. Surveys (n = 14,225 of 16,502) were completed anonymously during on-site briefings about the project. Persons unavailable during the site visits were contacted and asked to return their survey by mail (N = 1,968 of 8,749). Questions were designed to determine the prevalence of substance abuse and other health and fitness-related behaviors. Questions on stressful life events were included. Questions were used from large-scale federal surveys of civilian populations to facilitate comparisons. Very little information was collected on nutrition knowledge, eating behavior, history of weight loss/gain, fitness programs, or weight maintenance practices.
Personal communication, Goins, U.S. Army Center for Health Promotion and Preventive Medicine, Aberdeen, Md., 1996	*Health Risk Appraisal* (HRA)	Annual survey administered to approximately 75,000 active Army personnel during the course of a physical exam or other preventive medicine interview. Social security numbers are recorded, and a longitudinal database is maintained. Questions were designed to determine the prevalence of substance abuse and other health and fitness-related behaviors. Questions on stressful life events were included. Very little information was collected on nutrition knowledge, eating behavior, history of weight loss/gain, fitness programs, or weight maintenance practices.
Hourani, 1995, 1996	*Perceptions of Wellness and Readiness Assessment* (POWR'95)	Survey administered as a part of a 1995 research project that sampled all active-duty Navy and Marine Corps personnel using a stratified random sampling strategy. Personnel (N = 9,859 of ~12,000) were contacted in on-site briefings or by mail. Social security numbers were recorded. The survey was a composite survey including items form over a dozen standardized questionnaires. To facilitate comparisons, items were used from the SHRBAMP and the HRA (described above), as well as large scale federal surveys of civilian populations. Questions were designed to determine the prevalence of substance abuse, occupational/environmental exposures, and other health and fitness related behaviors, including nutrition knowledge, eating behavior, and history of weight loss/gain. Questions on health status, reproductive history, stressful life events and personality were also included.
Warber et al., in preparation	*Army Food and Nutrition Survey I* (AF&NS-I)	Information was collected from a convenience sample of 3,065 soldiers at 33 Army installations. Four hundred ninety-four women responded to the survey. The demographic profile of respondents was similar to that of the total Army. Surveys were completed anonymously during an on-site briefing about the project. Questions were designed to assess nutrition knowledge and attitudes, eating behavior, supplement use, history of weight loss/gain, tobacco use, and field feeding behavior.

TABLE 7-2 Department of Defense Medical Automated Information Systems with Relevant Data

Acronym	Name	Description
ADS	Ambulatory Data System	Captures client-specific encounter, diagnostic, and treatment data for clients visiting outpatient clinics
CDIS	Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) Detail Information System	Supports on-line, near real-time access to individual detailed CHAMPUS information
CEIS	Corporate Executive Information System (800) 865-7023	Provides a collection of databases designed to furnish Department of Defense health care managers with executive information for decision support
CHCS	Composite Health Care System	Provides a daily record of patient administrative and clinical data for military medical treatment facilities
DMIS	Defense Medical Information System	Provides a large repository of patient-level, population, normative, and financial data to support health care analysts and decision makers
MCQA	Managed Care Query Application	Provides ad hoc capabilities to medical treatment facilities for CHAMPUS, Biometrics, and patient population data
RCMAS	Retrospective Case Mix Analysis System	Provides clinical and management information; detailed patient level data; and workload and utilization data
TCSDB	Tri-Service CHAMPUS Statistical Database	Supports ad hoc research, analytical health outcomes studies, and Medical Analysis Support System (MASS) files

Recommendations for New Methods

The committee recommends that the military survey a representative sample of active-duty personnel individually and review the individuals' personnel and medical records during the course of an interview. This method would enable the investigator to obtain all the data needed in a single effort, ensure quality control of the data, build a database that would preserve the anonymity of the individual, and obviate the need to merge automated information systems with highly sensitive data. However, the need to create a system that will obtain information from several large and representative samples of the entire DoD over the course of several years may make this choice cost prohibitive.

An alternative recommendation is to expand the triennial *Survey of Health-Related Behaviors among Military Personnel* to include the demographic, medical, nutrition, fitness, and pregnancy data needed. Changing the questionnaire to include the social security number, as was done with the Navy's *Perceptions of Wellness and Readiness Assessment* survey and the Army's

Health Risk Appraisal survey, would permit a longitudinal and potentially integrated database to be developed. The practice of using questions from federal surveys of health and fitness-related behaviors in the general U.S. population should be continued so that comparisons between military and civilian populations can be made.

Additional Data Needed

As recommended by an IOM report (IOM, 1992), longitudinal studies of people admitted to military weight management programs should be conducted to determine the outcome of these programs as recommended changes in program procedures are implemented.

Career, active-duty, military women constitute a unique population of individuals who are required to maintain their weight and body fat and fitness at prescribed levels. Longitudinal studies of health risk factors (cardiovascular, musculoskeletal, diabetes) and outcomes are recommended in these women.

The DoD is encouraged to monitor pregnancy outcome (birthweight, preterm delivery, low birth weight infants, and congenital anomalies) as well as pregnancy wastage (miscarriage) according to service, rank, and MOS to identify potential problems associated with certain military jobs, physical training, or hazardous environments. It is recommended that health surveys be expanded to collect information on the pregnancy history of active-duty women. Suggested questions are those used by Evans and Rosen (1996).

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Appendixes

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A

Workshop Summary, Agenda, Participants, and Abstracts

WORKSHOP SUMMARY

INTRODUCTION

At the request of the sponsor, the Committee on Body Composition, Nutrition, and Health of Military Women (BCNH committee) held a workshop in Irvine, California, on September 9–10, 1996, entitled "Assessing Readiness in Military Women: The Relationship to Nutrition." The purpose of the workshop was to gather information from military personnel and civilian researchers on issues related to body composition, fitness, nutrition, and pregnancy as they pertained to active-duty servicewomen and to identify areas where further research is needed. This is a brief summary of the data presented and issues discussed. Included are references supplied by the guest speakers.

Demographics

Over 191,000 women serve on active duty in the U.S. Armed Forces (Verdugo, 1996), with another 140,000 women serving in the reserves (Herrold, 1996).[1] Women constitute 13, 14, and 17 percent of the personnel serving on active duty in the Navy, Army, and Air Force, respectively, but only 5 percent of those serving on active duty in the Marine Corps. In FY1995, women comprised 19, 20, and 24 percent of those enlisting in the Army, Navy, and Air Force, respectively, and 6 percent of those enlisting in the Marine Corps (Verdugo, 1996). Women are better represented among new enlistees than among active-duty forces for two reasons: the percentage of female enlistees has been increasing over the past several years, and women have a higher rate of attrition from the military than men.

The majority of women on active duty are enlisted personnel (84%), as are the majority of men (85%) (Bray, 1996). In each branch, the percentage of total enlisted personnel who are women is nearly identical to the percentage of total officers who are women.

The military population is a young one. An estimated 50 percent of active-duty women are between the ages of 17 and 25, and only 6 percent are over the age of 40.

The ethnic distribution among active-duty women differs from branch to branch and between enlisted personnel and officers. Overall, 40 percent of active-duty women classify themselves as minorities (African American, Hispanic, Asian American-Pacific Islander, Native American, and other). Minority group members comprise 53 percent of Army women (with the number of African American enlisted women exceeding the number of Caucasian enlisted women), 42 percent of Navy and Marine Corps enlisted women, and approximately 32 percent of Air Force enlisted women. (The percentage of minority women among officers is lower than that among enlisted women.) With the lifting of the combat exclusion laws in 1993, most positions in the military are now open to women, and occupational profiles of women have begun to change (Herrold, 1996). Although the majority of women still occupy support, administrative, and health care roles, more and more military women are accepting assignments to physically demanding jobs.

According to data presented by Naomi Verdugo (1996), 50 percent of military women have completed some college, 50 percent are married, and 50 percent are parents.

The military is concerned about maintaining the health and fitness of active-duty women (Bray, 1996; Verdugo, 1996). They are given free medical and dental care with an emphasis on preventive medicine and regular health checkups. In a survey of the four military services, 95 percent of active-duty women reported having had a Pap test in the last 3 years, and 82 percent reported that they received prenatal care in the first trimester of their last pregnancy (Bray, 1996).

However, a substantial proportion of military women make lifestyle choices that put their health at risk. For example, an estimated 30 percent of active-duty women smoke, 70 percent use alcohol regularly, 40 percent do not exercise at least three times a week for 20 minutes or more, 40 percent do not eat two full meals a day at least 5 days a week, and 40 percent do not sleep more than 6 consecutive hours at least 5 days a week (Bray, 1996).

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[1] Data presented at this workshop are drawn from a variety of military surveys. A list of these surveys is presented in Table A-1.

To maintain fitness and as part of their job, military women are expected to exercise and are screened at least annually for weight and fitness; however, anecdotal reports suggest that compliance with this expectation varies widely (see Table A-1; Bray, 1996; Friedman, 1996; Graham, 1996; Hernandez, 1996; Herrold, 1996; Picariello, 1996). An estimated 25 to 50 percent of women report that they currently exceed the military weight standard or have difficulty meeting the weight standard, while 5 to 15 percent report a height and weight that converts to a body mass index (BMI, weight in kilograms divided by the square of the height in meters) greater than 27 (Baker-Fulco, 1996; Bray, 1996; Hourani, 1996; Verdugo, 1996). It is not surprising then that a variety of studies of Army and Navy women have shown that from 42 to 79 percent are

TABLE A-1 Surveys of U.S. Military Active-Duty Women Quoted by Speakers at the Workshop

Speaker	Survey Cited	Sample
Drake	*Eating Disorders Inventory*	U.S. Naval Academy cadets
Baker-Fulco	*Total Army Injury and Health Outcomes Database*	Army active-duty personnel
Baker-Fulco, King	*Eating Attitudes Feelings and Behavior Study*	Selected Army personnel
Baker-Fulco, King	*Army Food and Nutrition Survey*	Selected Army personnel
Baker-Fulco; King	Brief study-unique questionnaires	Selected Army personnel, U.S. Military Academy cadets
Bray	*Survey of Health-Related Behaviors among Military Personnel*	Department of Defense active-duty personnel
Jones	*Health Risk Appraisal*	Army active-duty personnel
Hourani	*Nutrition Knowledge of Active-Duty Navy Personnel*	Navy active-duty personnel
Hourani	*Longitudinal Analysis of Lifestyle, Health, and Readiness*	Navy active-duty personnel
Hourani, Graham	*Perceptions of Wellness and Readiness Assessment*	Navy active-duty personnel
Sbrocco	*Health Survey of the Air Force*	Air Force active-duty personnel
Verdugo	*Sample Survey of Military Personnel*	Army active-duty personnel

trying to lose weight at any given time (Baker-Fulco, 1996; Drake, 1996; Hourani, 1996; King, 1996; Sbrocco; 1996).

Finally, an estimated 9 percent of active-duty women are pregnant at any given time. Available data suggest that pregnancy rates among active-duty women are lower than those of their age-matched civilian peers and that rates drop by more than 50 percent during troop deployment (Bray, 1996; Verdugo, 1996).

Readiness from a Command Perspective

CDR Susan B. Herrold, NC, USN (1996), presented to the BCNH committee an introduction to the components of military readiness. She stated that the primary mission of the military is to be warfighters, which leads to their operational primacy. According to Herrold, several factors have changed in military operations in recent years. These include the "operational tempo," or the rapidity of redeployment following completion of a mission, and the downsizing of the active-duty force, which has resulted in a decrease in the number of active-duty personnel. Both of these factors dictate that each individual soldier becomes much more important to the mission and has increased demands on her ability to perform. Overall readiness for a mission includes maximizing performance, minimizing unplanned losses, and adapting to changing environments; soldiers must be dependable, trained, healthy, physically fit, and well equipped. Among the day-to-day readiness issues, Herrold included health, fitness (both strength and flexibility), ability to withstand harsh environments (noise and extreme temperatures), and deployability at full-duty status (lack of injury or other incapacitating condition). Operational readiness issues include the ability to withstand irregular sleep and eating schedules, fatigue, limited medical resources, potential exposure to unfamiliar diseases, lack of hygiene, and such psychological stressors as lack of private toilet facilities. For women, this often results in voluntary decreases in fluid intake, leading to dehydration and its consequences. Herrold cited pregnancy and body composition issues as the most significant medical issues facing Navy women at the present time. She recommended that, although the Navy has taken the position that pregnancy is compatible with a Navy career, commanders must take the lead in advising young recruits to plan pregnancies at career-appropriate times.

BODY COMPOSITION AND FITNESS

Policy and Rationale

According to LTC Karl E. Friedl, USA (1996), the origin of military body fat standards can be traced to a report on the physical fitness of the services (DoD, 1981), commissioned by President Carter who, along with several generals, expressed concern about the decrease in fitness and increase in obesity among peace-time military personnel. In the 1981 report, appearance of unfitness was regarded as an indication of actual lack of fitness. Following the report came Department of Defense (DoD) Directive 1308.1 (1981), "Physical Fitness and Weight Control Programs," which required all services to institute a physical fitness program and

weight control regulations, fitness evaluations (physical fitness tests or PFTs), body fat standards for accession and retention, and an appearance standard. The directive, written by a group that included physiologists, mandated a weight control program that would use measurement of body fat as the final discriminator of fitness. In response, each of the services devised its own weight control regulations. The first tier could be a weight screen, but this would be followed, if necessary, by a circumferentially based body fat determination (based on equations) using the standard of hydrodensitometry, which was the best standard available at the time. The Marine Corps already had devised its own anthropometric equations, whose primary aim, according to Friedl, was appearance, since appearance was viewed as an indicator of fitness and performance.

Long-term health consequences were apparently only a secondary consideration to the developers of the original DoD standards. The original DoD recommendation limited body fat to 20 percent of body weight for men and 30 percent for women (15% and 25%, respectively, plus a 5% margin of error) based on physiological measures of fit young men and women, but some individuals providing input to the standards ordered a decrease in the 30 percent body fat for women to 26 percent because they saw no reason for women to carry that much more fat than men. A 1995 update of the original directive (DoDD 1308.1, "Physical Fitness and Body Fat Programs") now states that the maximum allowable limit for men is 26 percent and for women 36 percent, although each service maintains its own standards.

The current Army regulation (AR 600-9, 1986) contains allowances for age, with four age categories. In comparison, the Air Force regulation (AFPD 40-5, 1994) contains one age break at 30, while the Navy and Marine Corps regulations (OPNAVINST 6110.1D, 1990) are age neutral. The higher body fat allowance for Army personnel over age 40 (26 and 36%, for men and women, respectively) is at least health based, according to Friedl, since it corresponds to the BMI that is the surgeon general's threshold for increased cardiovascular risk. All services use gender-adjusted body fat standards.

The Army weight control program uses a weight-for-height screen as its first tier, followed by circumferential measures for those who exceed their weight limit. Data were shown from a 1988 study of male soldiers (O'Connor et al., 1990), illustrating that approximately half of those found to be overweight were within the allowable fat limits, which kept them out of the weight control program but which would be recorded in their records nonetheless.

The validity of the circumferential equations used by the military was discussed by Friedl (1996). Equations based on circumferential measurements replaced those based on the more commonly used skinfold measures because of the greater reliability of circumferential measures in field conditions. The men's equations differ slightly from one service to another, but all of them focus on a measure of abdominal circumference (since this is the primary site of male fat deposition), correcting for body size by measuring the circumference of the neck. Although these equations have been validated against underwater weighing (based on a two-compartment model of body composition), the latter method, itself, may not be valid for several reasons. Many military subjects cannot swim, resulting in a skewed sample or incorrect determinations. Moreover, one of the assumptions made in interpreting the data is that there are no individual differences in bone mineral density (BMD), when in fact there are significant ethnic differences in BMD. Efforts are being made to identify a better criterion method, such as the use of dual-energy x-ray absorptiometry (DXA) (based on a three-compartment model) and a four-compartment model that incorporates DXA. Although the male equations compare well

with DXA, according to Friedl, the female equations (which differ significantly among services) do not, particularly when used to measure longitudinal changes in body fat. In a study conducted by Westphal and coworkers (1995) of 150 women going through Army basic combat training (BCT), the use of a measure based on weight for height (BMI) surpassed the equations of all services in predicting body fat loss measured by DXA. The equations tended to underpredict fat loss, in some cases indicating fat gain.

Thus, Friedl (1996) recommended that the military consider replacing the anthropometric equations with simple BMI measurements, particularly for assessment of body fat loss or change in women. He also recommended more research on the time course and magnitude of changes in postpartum body composition and on the possibility that a lower minimal limit of body weight be set for women, in response to evidence that lower-weight women are at a significantly greater risk for early attrition.

LCDR René S. Hernandez, USN, MSC (1996), described the rationale for the Navy's body fat standard, which is based on the Metropolitan Life Insurance Company's tables of recommended weight for height (1983). The Navy standards originally limited men's body fat to 22 percent and women's to 33 percent. For reasons of appearance, an internal administrative decision subsequently reduced the upper limit for women to 30 percent body fat. Reversal of this decision is now under consideration. According to Hernandez, the decrease in the women's body fat limit is an indication that men continue to be judged by a standard that is compatible with health, while women are held to a standard that is appearance based. She added that in order to avoid using "appearance" as a retention standard, appearance is evaluated unofficially under the category of "military bearing." Body composition standards for accession and retention for each branch of the military can be found in Appendix B, Table B-1.

DoD Directive 1308.1 (1981) also includes a recommendation for fitness standards, and each service has developed programs and methods of evaluation of fitness (see Chapter 3 and Appendix B, Table B-1). The relationship of fitness to body composition and performance is not emphasized.

CDR Wayne Z. McBride, MC, USN (1996), provided a brief presentation on the efforts of a DoD committee to equalize body composition standards for accession across all branches of the military services and to "age neutralize" these standards. McBride also presented the possibility that the body composition standard should be based on BMI rather than on heights and weights or body fat.

The DoD effort to equalize standards is based on three perceived problems with current accession standards: first, height and weight accession standards currently allow both male and female recruits to exceed the service-specific body fat percentage limits for retention; second, a significant disparity exists in accession standards among the four branches. Finally, the difference between the maximum permissible accession weight for men and their maximum retention weight is greater than the comparable difference for women; thus, bias exists, with men judged to be qualified for accession at weights further from their ideal weight than are those for women. An analysis of the NHANES III database (Kuczmarski et al., 1994) also revealed that a significantly higher percentage of females than males in the general population would be disqualified from enlistment based on weight. The rationale for this difference is that according to statistics, male recruits lose significantly more weight than do female recruits during basic training, and men retain a greater weight loss. Friedl (1996) raised the question of whether there

are gender differences in weight loss physiology that should be considered. A number of other military speakers and attendees at the workshop offered an alternative explanation for the observations, namely that many, if not most, active-duty women work in sedentary jobs that do not promote time for fitness.

The question was raised regarding why appearance standards exist in the military and whether personnel would not be better served by eliminating these standards in favor of more stringent (job-related) fitness and body composition standards. Several of the military speakers expressed opposition to the appearance standard on the grounds that it is unrelated to health, fitness, and even body composition (a woman can be thin but overfat). COL Jeanne Picariello, USA (1996), emphasized that increasing the intensity of fitness training would increase fitness and decrease the number of personnel in danger of exceeding the weight standard. Friedl (1996) cited data showing that women with the largest waist-hip ratio have the greatest upper-body strength but that these women are also at higher risk for cardiovascular disease, which illustrates the point that peak performance standards may at times conflict with health and appearance standards. Others acknowledged, however, that the appearance standard will not be abolished because of the importance to the military of appearance as a deterrent (that is, "show of force").

The group was asked to help guide the committee to establish body composition standards that will best serve women's health and fitness. One request was to provide a medical or scientific rationale on which to base these standards. James A. Hodgdon (1996) explained that the Navy's body composition tables are based on the Metropolitan Life Insurance tables (1983) so there is at least some health basis. Friedl (1996) suggested the need for multiple standards with built-in risk thresholds. Others mentioned the need to address the use of smoking as a weight control measure by some military personnel.

The most salient point from this discussion was that the relationships among appearance, health, body composition, and fitness are not clear. The interaction between the latter two was the topic of the next session.

Estimations of Percentage of Soldiers In and Out of Compliance

Verdugo (1996) reported on the results of a spring 1995 Army self-report *Sample Survey of Military Personnel* of female soldiers. While the demographic data are summarized above in the introduction, survey data related to body composition and the difficulty women have meeting weight standards are reviewed here. These data are stratified according to ethnic group and military rank; data by military rank are presented in Table A-2. These self-reported data show clearly that female soldiers experience more difficulty meeting the weight standards than do male soldiers and that the higher ranked officers and enlisted women experience the greatest difficulty. As age increased, the difficulty for both men and women increased, but a greater percentage of female soldiers self-reported difficulty in meeting weight standards than did older male soldiers (Table A-2). Likewise, female soldiers were more likely to experience difficulty meeting the Army PFT (Table A-3).

TABLE A-2 Percentage of U.S. Army Personnel Surveyed Who Self-Reported Difficulty Meeting Weight Standards

	Rank of Officers		Rank of Enlisted Personnel		
	01–03	04–06	E2–E4	E5–E6	E7–E9
Male	14	17	15	17	16
Female	20	28	23	26	28

SOURCE: *Sample Survey of Military Personnel* (Verdugo, 1996).

Laurel L. Hourani (1996) summarized self-reported body composition data from the 1990 *Survey of Nutrition Knowledge of Active-Duty Navy Personnel*, a mail-in survey with approximately 3,000 respondents, of which 400 were female (73% response rate). Although only 9 percent of the females surveyed exceeded the percentage body fat standard (that is, 30% fat for females), 47 percent of the sample perceived themselves as overweight, and 60 percent were attempting to lose weight. More non-Caucasians than Caucasians exceeded the body fat standard, yet there was no difference in the percentages who were trying to lose weight. According to the survey, among those trying to lose weight, Caucasians relied equally on reducing caloric intake and increasing energy expenditure, whereas non-Caucasians were more likely to diet than exercise to lose weight. The problem of short-term dieting to meet the accession standards was highlighted by Hourani, who also noted that these same individuals may have chronic difficulties in meeting the retention standards if they fail to lose weight prior to weigh-in, which results in a pattern of weight cycling.

Current proposals by the Navy include: (1) increase the allowable fat for women to 33 percent, and (2) develop fair standards for women who fall outside of the height range of 58 to 71 inches. Because these heights form the limits to the Metropolitan Life Insurance table, some assumptions are made that may result in more stringent standards for individuals whose heights fall above or below those limits.

Robert M. Bray (1996) discussed the self-report *Survey of Health-Related Behaviors among Military Personnel*, which is conducted periodically among a cross-section of approxi-

TABLE A-3 Percentage of U.S. Army Personnel Surveyed Who Self-Reported Difficulty Meeting the Army Physical Fitness Test Requirements

	Rank of Officers		Rank of Enlisted Personnel		
	01–03	04–06	E2–E4	E5–E6	E7–E9
Male	5	8	16	9	8
Female	10	16	17	11	14

SOURCE: *Sample Survey of Military Personnel* (Verdugo, 1996).

mately 16,000 military personnel worldwide. In the 1995 survey among all age groups, men were twice as likely as women to report being overweight. Women were more likely to report poor health, however, less likely to engage in regular strenuous physical exercise and less likely to eat two or more meals per day.

Perceptions of Wellness and Readiness Assessment

Wendy F. Graham (1996) presented the results of the 1995 *Perceptions of Wellness and Readiness Assessment* (POWR'95), a self-reported questionnaire study of 25,000 Navy and Marine Corps personnel. The goal of the study was to provide baseline anthropometric and strength characteristics and blood pressure.

The most significant finding of this study was that, according to self-report, 46 percent of Navy women exceed the 30 percent body fat standard. Graham (1996) also reported that the largest proportion of women of all ethnic groups exceeding the height and weight standards are in the age ranges of 18 to 24 and 45 to 54. African American women fail to meet the standards more frequently than do other ethnic groups.

Graham (1996) proposed the use of three standards for retention in the Armed Services: (1) appearance, (2) performance, and (3) physical and mental health. As assessment tools, she proposed the use of: (1) a measurement of truncal fat for appearance by measurement of waist-to-hip circumference ratio, (2) the physical assessment test for performance, and (3) BMI for health. In her opinion, this recommendation would account for the available pool of recruits and provide an ethnically equitable standard.

Variation in Body Composition Due to Ethnicity or Gender

Lisa M. Stolarczyk (1996) presented data on ethnic differences in body composition. She indicated that although the densities of body compartments are based on cadaver analysis and are assumed to be constant (Table A-4), the possibility of inter- and intra-individual variability exists and depends on physiological conditions such as age, gender, diet, physical activity, genetics, and the degree of hydration of fat-free mass (FFM). The major ethnic variation in body composition is due to differences in bone density, skeletal muscle mass, and bone mineral mass

TABLE A-4 Assumed Densities of Body Compartments from Cadaver Analysis

Body Compartment	Density (g/cc)
Fat	0.901
Lean	1.100
Water	1.000

SOURCE: Data are from McArdle et al., 1996.

among ethnic groups. Stolarczyk suggested that the densities of FFM differ among ethnic groups, ranging from 1.111 g/cc in Asians to 1.097 g/cc in some Caucasians, depending primarily on hydration.

According to Stolarczyk (1996), prediction of body composition with a two-compartment model (fat and FFM) will systematically underestimate the relative body fat of Native American, African American, Asian, and Hispanic women by 2 to 4 percent because of differences in FFM density. Since the fat-free body density of Caucasian women may be less than 1.100 g/cc, their percentage body fat will be overestimated systematically by about 1 to 2 percent using the two-compartment model. Therefore, race- or ethnicity-specific conversion formulas should be used when estimating relative body fat from total body density to predict percentage body fat more accurately.

The use of a four-compartment model for estimating body composition would predict percentage body fat more accurately in all ethnic groups or in soldiers of mixed ethnicities according to Stolarczyk (1996) because this method accounts for differences in a major determinant of FFM density, namely bone. The method requires estimation of total body water using deuterium dilution and of BMD using DXA. This technique cannot easily be done in the field due to the limitations of these methods in the field.

Relationships Between Body Composition and Physical Performance

Hodgdon (1996) reported the results of a study of 62 male and 34 female Navy personnel (Beckett and Hodgdon, 1987; Hodgdon, 1992), in which the relationships between body composition and physical performance were investigated. The military-related physical performance tasks of lifting and carrying were studied and correlated with body composition data derived from a two-compartment model of fat and FFM (via hydrodensitometry). FFM, but not fat mass, was correlated positively with maximal box lifting capacity, strength measures, and box carrying. There were significant gender differences, with men performing better than women on all tasks (10% of women could not lift 100 lb). When data were corrected for FFM, differences between male and female performance disappeared. According to Hodgdon, these data suggest that FFM could be used as a screening tool for various occupations within the military. Although fat mass was associated positively with weight-bearing exercise (lifting and carrying), it was associated negatively with box carrying capacity and running performance. Hodgdon cautioned that any weight-bearing activity also has an endurance component after about 5 minutes of exercise and that even weight lifting had an endurance component after that time. Hodgdon also pointed out that this study was somewhat skewed in favor of the fit female, as those who could not generate 150 lb of upper-body strength were restricted from participation.

Hodgdon (1996) also described two additional studies comparing circumference-based percentage body fat assessment with hydrostatic weighing or DXA (Beckett and Hodgdon, 1987; Jette et al., 1990). These studies indicated that anthropometrically based classification of body fat in military women is not significantly better than BMI. According to Hodgdon, a gender-fair weight control standard could be limited to weight or BMI for women. He also noted that simple anthropometrics do not accurately assess changes in body composition.

Relatively weak relationships exist between percentage body fat and aerobic capacity, and there is no relationship between maximal lift capacity or other strength measures and adiposity.

Gender-appropriate body fat and/or body weight standards combined with an appropriate level of support to the individual (for example, physical training programs, dietary counseling, and well-equipped fitness facilities) should enhance physical readiness of all soldiers.

Fitness Tests and Programs

At the workshop, representatives from the Army, Navy, and Air Force described the fitness evaluations and programs used within each service. Descriptions of the current fitness test for each of the services can be found in Appendix B, Table B-1.

Picariello (1996) described the Army program for which she is responsible in her role as commander of the U.S. Army Physical Fitness School at Fort Benning, Georgia. Each year, this school trains 2,000 to 3,000 trainers who then work with the troops to assist them in developing ongoing, personal, physical fitness programs. The goal of these programs is to establish regular, intense training schedules so that personnel are able to accomplish their increasingly physical, demanding jobs. The programs are designed to be relevant and interesting by engaging troops in a variety of job-related activities. Intensity and duration of work are increased gradually so that troops have the satisfaction of continual improvement. Picariello emphasized that, within the Army, the physical fitness program is considered part of duty time. The major drawbacks to its success are the failure at the command level to support the physical fitness program as part of the soldier's duty, and the reticence on the part of the young soldier "raised in a sedentary lifestyle." She recommended a 5-d/wk program, emphasizing strength and endurance to ensure military fitness.

Picariello (1996) also described a 1994 study, the *Army Physical Fitness Update Survey* (Tomasi et al., 1995), conducted jointly by the U.S. Army Fitness School, U.S. Army Research Institute of Environmental Medicine, and U.S. Army Research Institute for the purpose of updating fitness standards (which were based on a sample of young men). In the 1994 study, 2,588 personnel were studied and found to be more fit than those surveyed in 1988, with half of the career women surpassing the maximum standard for the 2-mi run (twice the ratio of the career males) and female sit-up performance falling within 3 percent of that of males. Based on these results, Picariello recommended that fitness standards be adjusted for both genders, with sit-up and running test standards becoming more gender neutral and the push-up standard becoming less gender neutral. At the same time, she recommended de-emphasizing the PFT as a training goal, examining job requirements, increasing the intensity and work relatedness of physical training, and dealing with the health issues of smoking and repeated crash dieting. In de-emphasizing PFT as a training goal, she hopes to reorient the attitude of commanders and enlisted personnel to consider fitness training as an integral part of duty training and to avoid extreme behaviors to simply meet the PFT goal.

Hernandez (1996) described the Navy's approach to fitness, which focuses on ongoing physical fitness similar to that described by Picariello for the Army, although no formal Navy fitness trainer program exists as yet. As Hernandez described, the purpose of the Navy fitness program is to maintain the physical and mental stamina of sailors. Hernandez described the

physical readiness test (PRT: 1½-mi run, 2 minutes of sit-ups, 2 minutes of push-ups, and a sit-reach test) (see Appendix B, Table B-1) as similar to tests used in the civilian sector by the Cooper Institute for Aerobics Research. Although the pass rate is 92 percent, Hernandez presented data showing the number of individuals who were separated from the Navy in 1995 due to repeated failure to pass the PRT (either the body fat portion or the PRT): 494 enlisted personnel and 1 officer. She also discussed the Navy body composition standards and the role of remedial fitness programs in meeting those standards.

MAJ Sylvia C. Friedman, USAF (1996), described the creation of the Air Force physical fitness program in response to a 1996 directive from the Air Force Secretary and Chief of Staff. The Air Force has mandated that Health and Wellness Centers be established at all Air Force bases. At present, there are 22 functioning centers; when the final goal is achieved, more than 75 centers will have been established. According to Friedman, these centers will be managed by health promotion managers who are within the wing commanders' chain of command. Attached to the centers will be civilian experts in exercise physiology, nutrition, and stress management who will prescribe exercise and diet programs, as well as stress management techniques. Finally, a fitness specialist will be attached to each center to run the fitness programs there. Mobile training teams will travel among the bases to train the trainers, to ensure adherence to programs, and to check procedures used for the cycle ergometry test that assesses physical fitness.

Friedman (1996) emphasized the need to market physical fitness programs to the troops and to the commanders in order to ensure acceptance of these programs as a tool to enhance readiness, rather than as a mechanism for passing a test. She emphasized the possibilities of greater work capacity and fewer sick days as positive outcomes that the commanders can understand.

The replacement of the 2-mi run with the cycle ergometry test as the Air Force's measure of physical fitness was also discussed. According to Friedman (1996), the rationale for this change, which occurred in 1992, appears to be that several people had died or suffered serious cardiovascular complications while doing the 2-mi run. Although both tests measure aerobic capacity, which the Air Force believes to be the best measure of total fitness and work capacity, the cycle ergometry test is a submaximal stress test, whereas the run was, at least for many people, a maximal stress test. During the discussion, Friedman explained that the annual pass rate is 81 percent, and while the Air Force hopes the new test will promote regular workouts, only 50 percent of personnel report doing regular physical activity. She also mentioned that no one as yet has correlated performance on the cycle ergometry test with performance on the PFTs used by the other three branches.

Further, according to Friedman (1996), personnel must be counseled not to rely on an exercycle for regular workouts, as it does not involve weight-bearing exercise and thus cannot help prevent osteoporosis. In response to a question on the effectiveness of the military's remedial fitness programs, Friedl (1996) remarked that the recidivism and drop-out rate from the Army program is still quite high, so that, as yet, there is a policy rather than a program in place.

A brief discussion ensued on the ability of women with low body weight to perform to expectations. While none of the speakers found a problem with this, Hernandez (1996) reminded the group that because each branch of the military has a different mission, each has different performance standards. This fact argues against a single (DoD-wide) accession standard.

In summary, all three speakers emphasized the following points:

• Due to the availability of new weaponry and the nature of the new, smaller military that must be ready to deploy at a moment's notice and take all necessary equipment to the field, there is a greater need for "readiness" to incorporate an ongoing approach to physical fitness. The practice of preparing dramatically for a few weeks just before the fitness test is outmoded and inappropriate for the modern military.

• Development and enforcement by the leadership of an ongoing physical fitness program would contribute greatly toward ensuring passage of the body composition and fitness evaluations.

• The present fitness tests should be only a "point-in-time" evaluation of the effectiveness of an ongoing training program, not a goal in itself.

• Attainment of these performance standards, especially under circumstances of deployment when adherence to a fitness program becomes much more of a personal responsibility, requires that personnel spend time outside regular duty hours in training.

NUTRITIONAL ISSUES

In planning the workshop, the BCNH committee recognized that while active-duty women must meet nutrient requirements appropriate to their age, physiological state, and (possibly higher than average) activity level, an additional consideration for these women is the need to comply with weight-for-height and body composition standards. Among the consequences of actions taken to meet these standards might be alterations in nutrient intake that would affect overall health and readiness. Several of the workshop presentations indicated that a significant proportion of military women report dissatisfaction with their current body weight and a desire, as well as attempts, to lose weight. Thus, the survey data discussed at the workshop suggested a high prevalence of behavior aimed at meeting appearance and body weight standards; this behavior might affect overall nutritional status. Of particular concern was the potential impact of altered nutritional status on the menstrual cycle, bone health, and cognitive performance.

Assessment of Nutritional Status and Knowledge among Active-Duty Women

A primary concern of the BCNH committee was to identify available data assessing the actual nutritional status of active-duty women in a variety of settings. Several speakers in the introductory session reported the results of surveys of eating practices among active-duty women and men. Hourani (1996) summarized the results of three self-report surveys of nutrition knowledge and eating behavior among active-duty Navy and Marine Corps personnel. The 1990 *Health and Nutrition Survey* (Trent, 1992) and the *Follow-up for Fitness Survey* (Trent and Hurtado, 1997) found a strong association between nutrition knowledge and diet score among Navy personnel. POWR'95 surveyed over 10,000 Navy and Marine Corps personnel to assess the Navy's progress toward the goals of *Healthy People 2000* (DHHS, 1991). While women scored higher than men on many eating behaviors perceived as positive, such as eating breakfast, taking vitamins, and eating healthier foods, they also scored higher on wanting to lose weight, dieting, taking diet pills, and eating in secret (dieting behaviors are discussed in more detail

below). No relationship was observed between self-reported diet behavior and either body composition or physical fitness scores.

Bray (1996) reported on the results of the 1995 *Survey of Health-Related Behaviors among Military Personnel*, a DoD-wide survey. This survey showed that while active-duty women were less likely than men to consume high-fat meats, dairy products, and fried foods, women were no more likely than men to report consuming low-fat dairy products, high-fiber grain products, or vegetables, and they were only slightly more likely to report consuming fruit. Women were less likely than men to consume at least two meals a day. Related findings were reported by Edward Hirsch (1996) in the later session on nutrition. Based on a 1984 study of ration component preference (Wyant and Meiselman, 1984), he and his colleagues concluded that Army men indicated a preference for meats, eggs, fast-food sandwiches, and heavy desserts, whereas Army women indicated a preference for vegetable dishes (including salads) and fresh fruits. While the survey of food preferences clearly illustrated differences among men and women, Hirsch noted that the analysis of food preferences could lead to a menu preferred by both sexes, which could help overcome nutritional problems associated with military rations.

CDR A. J. Drake III, USN (1996), reported the results of a study he conducted with David W. Armstrong III and colleagues, which followed more than 250 female U.S. Naval Academy midshipmen from 1992 to 1996 and found that the median intake of calcium among these women was 900 mg/d, well under the Military Recommended Dietary Allowance (MRDA) (AR 40-25, 1985) for calcium (1,200 mg/d).

Finally, LTC Nancy King, USA (1996), reviewed the results of six Army nutrition studies that were conducted both in the field and in garrison between 1980 and 1993 (Edwards et al., 1991; King et al., 1994; Klicka et al., 1993; Kretsch et al., 1986; Rose et al., 1989; USACDEC/USARIEM, 1986), and included measurement of actual food intake of 278 female Army soldiers. The final study, conducted in a dining hall at Fort Jackson, South Carolina, was the first study specifically designed to determine female soldiers' food intake compared with the MRDAs (King et al., 1994). Thus, a study in garrison showed that the intake of calcium was less than 70 percent of the MRDA for over 60 percent of the female soldiers (King et al., 1994). The women gave two main reasons for not consuming more food: they were too full or they were not hungry. This suggests the possibility, according to King, that the nutrient density of the foods may be a problem and that female soldiers may not be able to eat enough to meet their nutritional requirements (particularly without gaining weight), given the food choices available. However, these intakes were similar to those reported for the general U.S. female population of comparable age, which suggests that the nutritional problems of military women in garrison may not be different from those of their civilian counterparts. Of greater concern to the military is the finding that, in general, intakes of energy, protein, calcium, iron, vitamin B_6, and folic acid were lower in the field than in garrison. As noted by King, while the specific cause of the lower food intake under field conditions is not known, a recent report of the Committee on Military Nutrition Research (IOM, 1995) suggested that field conditions, extreme environment, and type of ration served all contributed to the lower food intake. In addition, it was noted in the workshop discussion that some military personnel desire to lose weight during field operations and may restrict food intake during this period.

EATING DISORDERS AND DISTURBED EATING

Several speakers at the workshop presented evidence to suggest there are some women within all branches of the military who practice what could be termed "disordered eating" behaviors in an attempt to meet the body fat standards required for retention. That is, their eating behaviors meet some of the criteria for an eating disorder but not enough so as to qualify as a full-blown eating disorder.

Hourani (1996), for example, reported on POWR'95, which included several questions from the *Eating Disorders Inventory* (Garner and Olmstead, 1991). Results indicated that 11 percent of the women polled reported having taken diet pills in the previous year to achieve a desired weight; in addition, 13 percent of the women reported eating in secret, and 50 percent were unsatisfied with their present weight. All three factors (items from the *Eating Disorders Inventory*) were determined in prior studies of eating disorders to be highly predictive of disordered eating behaviors. Administration of the *Quick Diagnostic Interview Schedule*[2] to a group of 784 Navy and Marine personnel indicated a 1.5 percent lifetime prevalence and a 1.2 percent recent (within the previous year) incidence of bulimia (characterized by self-induced vomiting or laxative or purgative abuse for the purpose of losing or maintaining weight) similar to results reported for a group of college students (Pemberton et al., 1996).

Drake (1996) reported the results of ongoing studies involving U.S. Naval Academy midshipmen who took the *Eating Disorders Inventory*. Ten percent of women and 3.5 percent of men sampled showed evidence of being at risk for eating disorders. For women, this correlated with a tendency for greater weight gain in the first year and a greater incidence of menstrual dysfunction. However, no differences were seen in level of physical fitness. According to Drake, these observations could be accounted for by high stress levels.

Tracey Sbrocco (1996), in an overview of eating disorders among military women, emphasized that eating disorders as defined by the *Diagnostic and Statistical Manual of Mental Disorders, 4th edition* (DSM-IV, 1994) are uncommon in the military. The DSM-IV divides eating disorders into three categories: anorexia nervosa, bulimia nervosa, and "eating disorders, not otherwise specified (NOS)"; each has its own diagnostic criteria. Sbrocco cited the prevalence rate for anorexia both in the military and in the general population of young, Caucasian females as approximately 1 percent, with a prevalence rate for bulimia of 1 to 3 percent. What is also found among military women, she cautioned, is a high incidence of subclinical eating disorders, or disordered eating. An example she cited was chronic dieting. According to a *Health Survey of the Air Force*, for example, 40 percent of a sample of Caucasian women and 18 percent of a sample of African American women reported dieting chronically. Additional indications include restricting individual foods or food groups, engaging in compulsive exercise, and exhibiting a body image disturbance. She added that these factors may affect deployment by negatively affecting physical status and performance. She also cautioned, however, that all information regarding eating disorders and disordered eating in the military is subject to question because eating disorders represent grounds for separation; thus, the problem is at least partially a hidden one. She expressed the commonly held belief that because "appearance" is of primary

[2] *Quick Diagnostic Interview Schedule* is a shortened form of a long telephone survey based on the DSM-IV (1994), criteria for eating disorders.

concern in the Navy's policy on body composition, the most importance is placed on that attribute in retention and promotion, contributing to an underweight female military, despite the lack of strong association between a "fit" appearance and the ability to perform. Sbrocco made four recommendations regarding the identification, treatment, and prevention of disordered eating within the military setting: (1) collect more prevalence data; (2) make weight standards performance based; (3) use multimodal assessment of food intake, such as handheld computers; and (4) devise education-based prevention strategies.

Carol J. Baker-Fulco (1996) presented results of several self-report surveys of small samples of active-duty Army personnel (Baker-Fulco et al., 1997; King et al., 1994; Klicka et al., 1993; Rose et al., 1993). She emphasized that although the intent of the surveys had not always been to assess weight loss practices, the incidence of disordered eating behaviors, or preoccupation with weight, some relevant observations could be made from the responses. One observation from a survey on weight loss practices was that while 8.5 percent of women reported being on the weight loss program at the time of survey, 21 percent reported exceeding their weight-for-height limit (Rose et al., 1993), which suggests that a significant proportion of women chronically diet to lose weight prior to the next weight assessment. A larger self-report survey showed that as many as 45 percent of women in some rank categories exceeded their weight-for-height limit at the time of the survey (Baker-Fulco et al., 1997). A study of U.S. Military Academy, West Point, cadets revealed that 79 percent of females reported they were trying to lose weight (Klicka et al., 1993), a prevalence rate similar to the percentage of women in the larger study who said that they wanted to lose weight (Baker-Fulco et al., 1997). This latter survey as well as a survey only of women in BCT (King et al., 1994) found that a high percentage of women had both gained and lost weight within the past year, suggesting the prevalence of weight cycling. Finally, results of one survey suggested that those who were trying to meet their weight limit were the most likely to report the use of undesirable weight loss practices (Rose et al, 1993).

David M. Garner (1996) focused on two areas: the risk factors for eating disorders in the military population and the unique problems of screening for disordered eating in a military population. First, he emphasized the presence of many known risk factors for eating disorders among the military population: gender, restrictive dieting, weight and shape dissatisfaction, the crucial role of appearance in judgments of readiness, and prior history of weight problems. He cited the following observations as bases for his recommendation that the body weight and appearance standards should give way to performance-based standards: apparent lack of strong association between body weight and physical performance (fitness), absence of clear health risks for moderate overweight, and lack of effective treatment for obesity. He went on to discuss the assessment of eating disorders and stated that while false negatives are rarely considered a problem in eating disorders screening, such would not be the case if, as Sbrocco (1996) had mentioned, eating disorders were grounds for discharge from the military. He recommended that a valid screen for eating disorders should employ a previously validated, widely used screening instrument, rather than a newly designed instrument or part of an instrument. He also emphasized that it would be impossible to screen for eating disorders with any validity as long as an identified eating disorder can lead to discharge.

In summary, many speakers expressed a concern that the emphasis on appearance, and consequent undereating, may lead to a chronic state of "unreadiness" on the part of female military personnel. A deeper concern is the possibility that some highly active, weight-conscious

women may have or develop serious health problems such as the female athlete triad, described below.

Health Consequences of Undernutrition

In view of the apparent tendencies of military women to restrict food intake to meet weight and body composition standards, to undereat in field situations, and to fail to meet MRDAs for a number of vitamins and minerals even in garrison, a number of speakers presented data on the potential consequences of long- and short-term undernutrition to health and performance. These included concerns about bone growth and injury, reproductive function, and cognitive function.

Factors Influencing Bone Mineral Density

According to Richard J. Wood (1996), the maximum rate of bone mass accrual occurs during linear growth. During the decade of 20 to 30 years of age, most women have achieved maximum linear growth in bone but have not yet acquired their peak bone mass. During this period, 10 to 20 percent of bone mass is acquired. The difficulty in meeting calcium requirements from military rations as well as reports of stress fractures among young military women have raised concerns about bone health. COL Bruce H. Jones, USA (1996), reported that the incidence of stress fractures in women during BCT at Fort Leonard Wood, Missouri, is higher than among men. The incidence of injuries in both men and women during BCT was related to level of fitness and has increased in recent years. (During the discussion period, it was noted that the reported level of stress fractures was not unusually high, given the level of training involved.)

Wood (1996) presented a list of the factors that influence BMD: genetics, diet (including calcium intake), pregnancy and lactation, lean body mass, weight loss, physical activity, alcohol intake, and smoking. Findings related to these factors are summarized as follows:

Genetics. Wood (1996) indicated that about 80 percent of the variance in BMD is due to genetic factors. Among U.S. women at every age, African American women have a higher peak bone mass than Caucasian women, and African American premenopausal women have higher bone density than Caucasian premenopausal women (Looker et al., 1995). In both African American and Caucasian women, variation in genotype of the vitamin D receptor (VDR) gene predicts BMD. The variation in genotype is based on the presence or absence of a restriction enzyme site in the VDR gene, giving rise to two alleles of the gene; data have shown strong correlations among VDR genotype, markers of bone turnover and BMD in premenopausal Caucasian and African American women (Fleet et al., 1995; Morrison et al., 1994). However, more recent studies have found variable results (Cooper and Umbach, 1996).

Diet. An analysis of multiple studies indicates that calcium intake is positively associated with bone mass in premenopausal females (Recker et al., 1992).

Pregnancy and lactation. Parity does not predict hip BMD in women 60 to 89 years of age (Kritz-Silverstein et al., 1992). However, bone loss from the femoral neck is significantly higher in lactating than nonlactating women (Sowers et al., 1993). During lactation, approximately 5 percent of BMD can be lost even with a high calcium intake, but this loss can be regained during the postlactation period.

Lean body mass. Lean body mass is correlated positively with total body bone mineral content among 10- to 26-year-old twin females (Young et al., 1995).

Weight loss. Small increments in weight loss are not associated with loss of total body BMD in adult women. However, larger increments in body weight loss are associated with loss of BMD. In a group of women aged 18 to 44 years, an average weight loss of 4 kg (8.8 lb) over 6 months was associated with an average bone loss of 0.7 percent, and at weight loss greater than 10 percent of body weight, there appears to be a linear relationship between degree of weight loss and loss of BMD (Ramsdale and Bassey, 1994).

Physical activity. In young women, activity is associated with an increase in BMD under most circumstances, and exercise intervention can slow loss of BMD (Friedlander et al., 1995; Recker et al., 1992). This relationship appears to be complicated by menstrual status in part because amenorrhea is associated with loss of BMD and bone mass (Hetland et al., 1993).

Alcohol and smoking. Alcohol intake is not associated with lower femoral BMD (Laitinen et al., 1993). In contrast, heavy smoking (20 or more pack years) results in significantly lower BMD in the spine and femoral neck (Hopper and Seeman, 1994). During the discussion period, it was noted that caffeine intake and high protein intake have been associated with increased urinary calcium excretion.

Female Athlete Triad

Michelle P. Warren (1996) discussed the female athlete triad, which is a triad of disorders (disordered eating, amenorrhea, and skeletal abnormalities, including osteoporosis) that may occur in female athletes who train vigorously (especially those competing in appearance or endurance sports) and in ballet dancers. Knowledge concerning this triad may be of relevance to women in the military because of the emphasis on appearance and performance, two key factors that predispose to the female athlete triad.

Eating disorder component. According to Warren, the first component of the triad among the lower weight groups involves eating disorders, including starvation, vomiting, and purgative or laxative abuse. According to Garner (1996), the short- and long-term health consequences of eating disorders include fatigue, muscle weakness, cramps, cardiac arrhythmias, renal disturbances, dental destruction, swollen salivary glands, cerebral atrophy, and skeletal abnormalities.

The triad described for endurance athletes is associated with a slight energy intake deficit that results in a depressed metabolic state (Yeager et al., 1993). It is this energy deficit that is believed to give rise to the reproductive component of the triad. Overemphasis on appearance, fitness, and body weight may predispose to severe energy restriction relative to energy expenditure, that is, disordered eating.

Reproductive component. The second component of the triad consists of amenorrhea, which is defined as the absence of three to six consecutive menstrual cycles, or delayed menarche (to over 14 years of age), accompanied by a decrease in estrogen production. Another variation in hormonal dysfunction is a short luteal phase caused by inadequate progesterone synthesis secondary to a dysfunctional corpus luteum. Women with this abnormality have either amenorrhea or more frequent periods. The syndrome appears to afflict those in the lowest weight groups, such as gymnasts and runners.

Skeletal component. The third component of the triad is low bone density, which predisposes a person to pathological stress fractures, osteoporosis, and osteonecrosis. Bone demineralization similar to that observed in postmenopausal women and lack of normal bone development can be severe and are primarily the result of hypoestrogenemia. Thus, the normally beneficial effects of exercise on bone density can be negated if a hypoestrogenic amenorrhea is associated with an increase in exercise intensity. However, this reduction in bone mass is refractory to estrogen replacement therapy. In addition, weight gain may not be accompanied by an increase in bone density, which suggests a permanent effect (Constantini and Warren, 1992).

Mechanisms. Two theories prevail regarding the mechanism responsible for the female athlete triad. The first theory is that uncompensated negative energy balance due to chronically inadequate food intake leads to amenorrhea and reduced bone density. The second is that activation of the hypothalamic-pituitary-adrenal axis increases cortisol secretion, which in turn decreases the secretion of gonadotropin-releasing hormone, with resulting in changes in estrogen secretion and associated bone loss or a direct effect of cortisol on bone.

Military Factors, Menstrual Irregularities, Bone Mineral Density, and Stress Fracture Risk

The factors just described are important for bone health of all women, regardless of whether they are in the military. Specific questions about bone health for female military personnel have focused on the potential impact of training activities as well as actions taken by women to remain in compliance with body weight and body composition standards.

personnel have focused on the potential impact of training activities as well as actions taken by women to remain in compliance with body weight and body composition standards.

Jones (1996) presented the results of recent studies conducted with BCT units at Fort Leonard Wood, Missouri, which indicated that women in BCT had a 9 percent rate of stress fracture compared with 3.5 percent for the men (Canham et al., 1996). When risk of stress fracture is plotted against running speed (as an indication of fitness level), the curve is J shaped, with a small increase in risk for those with the fastest times and increasing risk for those with slower run times. Neither body fat nor BMI show strong associations with stress fracture risk in this population. Instead, women in the lowest and highest BMI groups appear to be at greatest risk, with a 2.5-fold increase in stress fracture risk among the highest BMI group. The most consistent observation among women in BCT is that lower fitness (and not fatness) levels tend to be associated with higher risk. No data were presented on the prevalence of menstrual problems secondary to training in this study.

Drake (1996) presented findings of an ongoing study he is conducting with Armstrong and colleagues to examine the factors associated with stress fracture and BMD in female midshipmen during their first year at the U.S. Naval Academy (average age at entry, 18.4 ± 0.9 years). Drake reported that U.S. Naval Academy stress injury rates for women are approximately 12 percent, compared with 3.4 percent for male midshipmen. The purpose of the ongoing study is to test two hypotheses: first, that low BMD is a significant risk factor for stress fractures, and second, that stress-induced oligomenorrhea or amenorrhea (and increased cortisol levels) might lead to lower BMD and increased risk of stress fractures. Results to date have shown that midshipmen are under high levels of stress, with cortisol concentrations at the high end of the normal range. Ten to 15 percent of first-year female midshipmen experience oligomenorrhea (defined as seven or fewer menses within a 12-mo period) during the first year. Five to 6 percent experienced amenorrhea (defined as two or fewer menses in a 12-mo period). Total body bone mineral content and tibial BMD increased over the first year regardless of menstrual status. However, hip BMD decreased with increasing menstrual dysfunction. Thus far, no association has been observed in the midshipmen between stress fracture incidence and menstrual status, but stress fractures are associated with a 6 percent decrease in BMD. Studies in this population of female military personnel are being continued.

Friedl (1996) reported that studies in young Army women have identified an association between increased prevalence of stress fractures and previous history of amenorrhea (which they defined as an absence of menses for greater than 6 months), as well as with smoking and previous family history of osteoporosis, while African American ethnic origin was found to be a negative risk factor (Friedl et al., 1992). These data, taken together, point to the potential role of menstrual status in influencing the impact of activity associated with military training on bone health.

Diet and Cognitive Function

Harold H. Sandstead (1996) summarized early reports from his laboratory and others demonstrating the importance of iron status in scholastic achievement and cognition of young children (Pollitt et al., 1982; Webb and Oski, 1973), and pilot work by Darnell and Sandstead (1991) indicating that iron repletion improved short-term memory in women. The rationale for

current studies is based on evidence that serum ferritin concentrations are low in a significant percentage of young women in the United States. Low serum ferritin concentrations are associated with an increase in the disappearance constant and turnover rate for zinc. Preliminary data were then presented illustrating the potential role of zinc in improving the response to certain standardized skill tests. The effect of zinc repletion, with or without additional micronutrients, was studied in Chinese school children (Penland, 1997). Supplementation with zinc alone improved (1) the number of taps by subjects on a keyboard in an interval of time, a test of neuromotor function; (2) the ability to match complex designs; and (3) concept formation or recognition of oddity.

A decline in the consumption of red meat by young women, as has been observed among young civilians and active-duty women (Briggs and Schweigert, 1990; Personal communication, LTC A. D. Cline, U.S. Army Research Institute of Environmental Medicine, Natick, Mass., 1996) is likely to contribute to an increased risk of inadequate iron and zinc intake. A study by Sandstead and coworkers to determine the impact of zinc supplementation, with or without iron or other micronutrients, on neuropsychological function in healthy women aged 19 to 40 years is currently under way.

In summary, results from a number of surveys of eating practices and preferences among military personnel show that active-duty women are concerned about body weight: prefer fruits and vegetables to meats and dairy foods, but are no more likely to consume them than are men; and frequently skip meals. According to the results of food intake studies reported by King (1996), the nutrient density of military rations may not be adequate to meet the nutrient needs of female soldiers within their optimal energy intake. Because approximately 50 percent of women in the military are over 25 years of age, consideration must be given to surveying these women adequately with respect to nutritional status. She also emphasized that nutrition education programs should be targeted to help women understand food choices that are low in fat and nutrient rich (dense). Studies reviewed by Baker-Fulco (1996) suggested that a significant percentage of active-duty women report exceeding the weight standards and that these women are likely to engage in unhealthy dieting practices prior to weigh-ins.

The potential health consequences of restrictive dieting were reviewed by several speakers. Wood (1996) reviewed the factors influencing BMD, including genetics, physical activity, hormonal status, smoking, and diet. Warren (1996) presented a review of the female athlete triad, a syndrome of disordered eating associated with altered reproductive status and compromised BMD. Drake (1996), Friedl (1996), and Jones (1996) reviewed studies of stress fracture incidence among female U.S. Naval Academy midshipmen and Army recruits; these studies pointed to a role for amenorrhea and fitness in helping to determine risk for stress fracture. Finally, Sandstead (1996) presented the results of recent and ongoing studies to examine the effect of zinc and iron repletion on cognitive function in children and in young active-duty women.

PREGNANCY AND LACTATION

Pregnancy Rates and Reproductive History among Military Women

According to the Army *Sample Survey of Military Personnel* (as reported by Verdugo, 1996), 9 percent of enlisted females reported giving birth between spring 1994 and spring 1995. Pregnancy and childbirth accounted for 11 percent of the 27 percent absentee rate for women during this time period. The absentee rate for male soldiers was 17 percent. In the Army, the percentage of pregnant females is less than that among similarly aged females in the U.S. population as a whole. Taking the most recent civilian data available (Ventura et al., 1997), the percentages of females in each age group who gave birth in 1996 were as follows: 8.7 percent of those aged 18 to 19 years; 11.1 percent of those aged 20 to 24 years; 11.4 percent of those aged 25 to 29 years; and 8.5 percent of those aged 30 to 34 years.

Between December 18, 1995, and July 23, 1996, 80 of the 2,327 (3.4%) female soldiers deployed to the Operation Joint Endeavor were returned because of pregnancy. Eighty-eight other female soldiers were returned from the Operation Joint Endeavor for nonpregnancy-related medical reasons during this same time. Including all medical causes, 7.2 percent of the women were returned, compared with 2.5 percent of the men (Smith, 1996).

Navy hospital records on the annual number of pregnancies yield 8 to 9 percent of enlisted women (Calderon, 1994). Self-reported data from the Navy consistently have shown pregnancy rates to be 8 to 9 percent of enlisted women (Thomas and Edwards, 1989; Thomas and Thomas, 1993). Women under age 25 accounted for almost 65 percent of the pregnancies. Like their civilian counterparts, more than half of these younger servicewomen reported that the pregnancy was unplanned, although 56 percent had been using some form of birth control. The incidence of unplanned pregnancy constitutes a source of significant disability and affects readiness, according to CDR Michael John Hughey, MC, USNR (1996).

According to Bray (1996), the majority of active-duty women report easy access to OB/GYN care (73%), and most were satisfied with services received (62%). In 1995, about 18 percent of military women reported that they had been pregnant within the past year, and another 1.5 percent reported they may have been pregnant at the time of the survey. Across all services, 38 percent of military women had been pregnant in the past 5 years (Table A-5). The vast majority (82%) of military women who had been pregnant within the past 5 years received pre-

TABLE A-5 Pregnancy History of U.S. Military Women (%)

	Army	Navy	Marine Corps	Air Force	Total DoD
Never been pregnant	37.5	44.6	38.4	41.7	40.9
May currently be pregnant	2.2	1.4	0.9	0.9	1.5
Pregnant in the past year	17.4	16.4	21.6	19.2	18.0
Pregnant in the past 1–2 years	7.7	6.7	8.4	7.3	7.3
Pregnant in the past 2–5 years	13.2	13.1	14.8	12.6	13.0
Pregnant more than 5 years ago	22.0	17.8	15.7	18.2	19.3

SOURCE: *Survey of Health-Related Behaviors among Military Personnel* (Bray et al., 1995).

natal care within the first trimester of their pregnancy. About 14 percent of women who were pregnant in the past 5 years consumed some alcohol during their most recent pregnancy. About 3 percent of pregnant military women drank several times a month or more often. About 84 percent of military women who were pregnant in the past 5 years reported no cigarette use during their most recent pregnancy, about 16 percent reported some cigarette use, and approximately 3 percent reported heavy cigarette use.

Military Policies for Pregnant and Postpartum Soldiers

Army

As described by Paul N. Smith, COL MC USA (Ret) (1996), pregnant soldiers are issued an activity profile that is designed to "protect the fetus while ensuring productive utilization of the servicewoman" (AR 40-501, para 7–9c, 1995). Pregnant soldiers are considered detrimental to unit readiness because of nondeployability, activity limitations, lost duty time, and unit morale effects. Postpartum soldiers are excused from fitness testing for 135 days and from Army body composition program standards for 6 months postpartum.

According to regulations, pregnant women are nondeployable and exempt from physical training, testing, wearing of load-bearing equipment including web belt, exposure to chemical agents, MOPP (Mission Oriented Protective Posture) for NBC (Nuclear, Biological, and Chemical) training, and immunizations except flu and tetanus-diphtheria. At 20 weeks, pregnant women are exempt from standing at parade rest/attention for more than 20 minutes, weapons training, swimming qualifications, drownproofing, and field duty. No assignment to duties where nausea, easy fatigability, or sudden lightheadedness would be hazardous to the soldier or others is permissible. At 28 weeks, the work week of a pregnant woman should not exceed 40 hours, including an 8-h workday with a 15-min rest period every 2 hours.

A postpartum profile is issued at hospital discharge. physical training is recommended at the woman's own pace for 45 days. Postpartum women are exempt from physical training testing for 135 days, weigh-in for 6 months, and deployment for 4 months. According to Smith, medical clearance is required before a woman's exemption from body composition and physical training testing is lifted.

Navy

Policies regarding the assignment and utilization of pregnant servicewomen in the Navy are based on known pregnancy physiologic changes, perinatal risks, and known or suspected environmental hazards. According to Hughey (1996), physiologic changes of pregnancy include increased cardiac output, heart rate, respiratory rate, and metabolic rate; decreased strength and athletic performance; diminished subjective workload; softening of cartilage and ligaments, which increases vulnerability to trauma and exercise-induced injury; impaired balance and danger of falling due to increasing weight, shifting center of gravity, and early disequilibrium; slower gastrointestinal tract motility; and increased energy extraction from food. Common problems associated with pregnancy include constipation, nausea, heartburn, sciatica, low back

pain, and carpal tunnel syndrome. During pregnancy, the military woman is more vulnerable to joint injuries, falls, chemical exposure, and contact allergens. The fetus inadvertently may be exposed to heat, vibration, sound, trauma, and teratogens. In humans, heat exposure has been shown to increase the risk of neural tube defects, although not all studies confirm adverse effects. In industrial environments, noise has been found to increase the incidence of spontaneous abortion, threatened abortion, premature labor, pregnancy-induced hypertension, fetal death, and low birthweight. Even though the abdominal wall attenuates sound, fetal hearing is not totally protected. Exposure to low-frequency, whole-body vibration and organic solvents, pesticides, and other chemical agents all are associated with pregnancy complications. Trauma during the second and third trimesters could result in placental abruption, fetal injury, premature rupture of membranes, and premature labor and delivery (OPNAVINST 6000.1A, 1989).

Hughey (1996) described Navy policies for pregnant women, including the 20-wk rule, the 6-h rule, and the commanding officer's prerogative (defined below, OPNAVINST 6000.1A, 1989). Physical training is restricted during pregnancy and for 6 months following delivery, along with weight standards. Standing at parade rest/attention is restricted to less than 15 minutes and work week is limited to less than 40 hours per week. Limited HAZMAT exposure is enforced. Overseas assignments are often restricted. Transfer (permanent change of station) while pregnant is disallowed. Discharge from the Navy depends on particular circumstances. Convalescent leave after uncomplicated vaginal delivery or cesarean section delivery is 6 weeks.

Naval Operations Instruction 6000.1A (1989) established the 20-wk rule, which dictates that pregnant women will not remain aboard ship after the twentieth week of gestation. The commanding officer's prerogative states that prior to the twentieth week, the ship's commanding officer will decide whether the pregnant woman may remain aboard safely. The 3-h rule states that in order for a pregnant woman to remain aboard the ship safely, medical evacuation to a treatment facility capable of evaluating and stabilizing obstetric emergencies must not exceed 3 hours. In 1989, the 3-hour rule was extended to 6 hours.

Air Force

Air Force pregnancy policy was not discussed at the workshop. The policy is outlined in Chapter 6 and Appendix B, Table B-1.

Postpartum Return to Duty Readiness: Lactation

Concern was raised as to whether inadequate gestational weight gain might adversely affect lactation performance. Megan A. McCrory (1996) presented observational studies from industrial countries that have not shown any association between gestational weight gain and lactation performance. However, an indirect effect could be mediated through birthweight, since birthweight is correlated with milk intake due to infant demand. Within the normal range of weight gains, there is no evidence that gestational weight gain will affect lactational performance.

Rates of weight loss during lactation have been studied in healthy, well-nourished populations (Boardley et al., 1995; Brewer et al., 1989; Butte et al., 1984; Dewey et al., 1993;

Dugdale and Eaton-Evans, 1989; Forsum et al., 1989; Heinig et al., 1990; Janney et al., 1997; Keppel and Taffel, 1993; Kramer et al., 1993; Manning-Dalton and Allen, 1983; Morse et al., 1975; Nommsen et al., 1991; Öhlin and Rössner, 1990; Parker and Abrams, 1993; Potter et al., 1991; Schauberger et al., 1992; Scholl et al., 1995). According to McCrory, these longitudinal data consistently indicate an average rate of weight loss of 0.6 to 0.8 kg/mo during the first 4 to 6 months postpartum, but there is wide variation among women. Weight loss continues between 6 to 12 months postpartum but at a slower rate (Heinig et al., 1990; Nommsen et al., 1991). Rates of weight loss in this latter study were 0.5, 0.8, 0.2, and 0.1 kg/mo at 3, 6, 9, and 12 months postpartum, respectively.

Exercise during Lactation

McCrory (1996) presented findings from Lovelady et al. (1990), who conducted a cross-sectional comparison of eight sedentary and eight highly-trained, exercising women who were breastfeeding exclusively. The latter group exercised an average of 88 min/d and their estimated energy expenditure was 700 kcal/d higher than the sedentary group. Vigorous exercise did not adversely affect lactation performance.

The effects of an exercise program on lactation performance were studied in a randomized intervention trial (Dewey et al., 1994). The experimental group undertook aerobic exercise 45 min/d, 5 d/wk for 12 weeks; and the control group partook in vigorous exercise no more than once per week. An increase in aerobic capacity was seen in the exercising group, but there was no difference in weight loss or body composition because they consumed more food. No adverse effects on lactation performance or infant weight gain were observed in the exercising group. Thus, breastfeeding women apparently can undertake exercise without jeopardizing milk volume or composition. One report cited a transitory increase in lactic acid in breast milk following exercise, but this is not a problem for most infants (Wallace et al., 1992).

Military Concerns

Military attendees at the workshop emphasized the need for scientifically based recommendations regarding appropriate weight gain, how much time to allow active-duty women to return to their prepregnancy weight, and whether these recommendations should consider individual factors such as total pregnancy weight gain and whether or not the woman is breastfeeding. Several speakers questioned whether active-duty women should receive more encouragement to breastfeed, given the beneficial effects on the infant and influence on postpartum weight loss.

QUESTIONS RAISED AT THE WORKSHOP

While the workshop presentations provided a context within which to consider the questions posed by the military, the presentations also raised a number of additional questions. Some of these fit within the framework of the questions originally posed by the military and became

topics for consideration in the final report, while others may lead to suggestions for future research.

Demographics

- What is the weight-for-height or BMI profile for active-duty women in all services?
- What is the prevalence of overweight or excess body fat for each service (according to service-specific standards)?
- What are the typical weight and fitness management practices across a representative sample of military sites?
- What percentage of personnel are separated from service each year for body fat or fitness violations?

Body Composition and Fitness

Minimum Lean Body Mass

- What levels of minimum lean body mass, and/or maximum body fat, are compatible with readiness (health, physical and cognitive performance, appearance)?
- How should the gender-specific differences in sites of fat deposition be best considered in establishing appearance or body composition standards?
- Should lean body mass be used as a criterion for job assignment due to its relationship with performance?

Appearance versus Health

- Should health be considered as the primary determinant of readiness, or should appearance be considered?

Minimal Accession Standards

- Should body composition standards for accession be lower than those for retention so that recruitment quotas are met? Can new recruits who exceed retention standards slim down and train up during BCT or the ensuing year in a manner compatible with optimum health and performance?
- Do women have a more difficult time losing excessive body weight and maintaining a body weight that is appropriate for the standards?

Nutritional Issues

- Will the results of previous food intake studies in small groups of women be borne out by larger studies that include more women?

- What is the energy expenditure of active-duty women in the field?
- Aside from energy, what nutritional factors influence the menstrual cycle and reproductive function?
- Do physically active women require less calcium to maintain bone density?
- Given the association between weight loss and decreases in BMD, what are the implications for BMD in individuals who are weight cycling?
- What are the influences of dieting, iron status, and other nutrient statuses on cognitive function (short-term memory) in active-duty women?
- Is protein intake adequate when women rely on operational rations, and how does the protein level of rations influence calcium status?
- Are women's protein requirements influenced by endurance exercise?

An expert panel, which was asked to design a training program that would reduce injuries, made recommendations to the Marines that decreased the amount of weight-bearing activity for women during training (i.e., running). Jones noted that recruits were able to achieve their desired level of fitness with fewer stress fractures. The Marines modified this recommended program to increase the amount of running. What data are available?

Pregnancy and Lactation

- What is known about the reproductive history of military women (menstruation regularity, fertility/infertility, contraception)?
- What is the average gestational weight gain of military women?
- What are the pregnancy complications in military women?
- Are military women at risk for poorer reproductive outcome due to low BMI, excessive exercise, anemia, adverse environmental conditions, and stress? What is the impact of low iron and folate status on pregnancy outcome?
- What data are available on the reproductive outcome of military women by rank, ethnicity, and age? How representative are these data of all enlisted servicewomen and officers?
- What factors may be implicated in the increase in low birth weight among offspring of military women, and what recommendations should be made?
- What is the impact of physical activity and exercise on pregnancy outcome?
- What is the rate of weight loss postpartum?
- Do military women attain weight, body fat, and fitness standards by 6 months postpartum?
- What is the incidence and duration of lactation?
- Is there a desire to breastfeed, and what is the feasibility of breastfeeding when redeployment is an option?

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WORKSHOP AGENDA

ASSESSING READINESS IN MILITARY WOMEN: THE RELATIONSHIP TO NUTRITION

A Workshop Sponsored by
Committee on Body Composition, Nutrition and Health of Military Women
Food and Nutrition Board, Institute of Medicine

September 9–10, 1996
Arnold and Mabel Beckman Center
National Academies of Science and Engineering
Irvine, California

AGENDA

Monday, September 9, 1996 **Lecture Room**

7:30 a.m. *Breakfast available in the refectory*

I. WELCOME AND INTRODUCTION TO THE TOPIC

8:30 a.m.–8:45 a.m. Welcome and Introductions
Barbara O. Schneeman, Chair, Committee on Body Composition, Nutrition and Health of Military Women

Presentations are 15 minutes in length followed by a 5 minute discussion period

8:45 a.m.–9:05 a.m. Military Readiness of Women: An Overview from the Command Perspective
CDR Susan B. Herrold, NC, USN, Bureau of Medicine and Surgery (BUMED), Washington, DC

9:05 a.m.–9:25 a.m. Profile of the Military Woman
Naomi Verdugo, U.S. Army Office of the Deputy Chief of Staff for Personnel, Washington, DC

9:25 a.m.–9:45 a.m. Health and Nutrition Profile of Women in the Navy
Laurel L. Hourani, Naval Health Research Center, San Diego, CA

9:45 a.m.–10:00 a.m. Break

10:00 a.m.–10:20 a.m. Characteristics of Female Midshipmen: 1992 to 1996
CDR A. J. Drake, III, USN, National Naval Medical Center, Bethesda, MD

10:20 a.m.–10:40 a.m. Health, Fitness, and Nutrition Among Military Women and Men
Robert M. Bray, Research Triangle Institute, Research Triangle Park, NC

10:40 a.m.–11:00 a.m. Disordered Eating Among Women in the Armed Forces
Tracey Sbrocco, Uniformed Services University of the Health Sciences, Bethesda, MD

11:00 a.m.–11:40 a.m. Part I Discussion

II. Body Composition and Fitness

11:40 a.m.–12:00 p.m. Body Composition and Physical Performance of Women
James A. Hodgdon, Naval Health Research Center, San Diego, CA

12:00 p.m.–12:20 p.m. Methodological Problems in the Assessment of Women's Body Composition by the Military: Identification of Valid and Reliable Methods for Field Use
LTC Karl E. Friedl, USA, U.S. Army Medical Research and Materiel Command, Ft. Detrick, Frederick, MD

12:20 p.m.–1:30 p.m. Lunch

1:30 p.m.–1:50 p.m. Ethnic Differences in Body Composition: Application to Active Military Women
Lisa M. Stolarczyk, University of New Mexico, Albuquerque

1:50 p.m.–2:10 p.m. Cross-Sectional Profile of Body Composition Among Active-Duty Navy and Marine Corps Personnel
Wendy F. Graham, Naval Health Research Center, San Diego, CA

2:10 p.m.–2:30 p.m. Accession Weight Standards: Inconsistencies and Gender Bias
CDR Wayne Z. McBride, MC, USN, Uniformed Services University of the Health Sciences, Bethesda, MD

2:30 p.m.–3:10 p.m. Part II Discussion

3:10 p.m.–3:30 p.m. Break

III. FITNESS ASSESSMENT

3:30 p.m.–3:50 p.m. Assessment of Fitness in the Army: Current Approaches and Standards
COL Jeanne Picariello, USA, U.S. Army Physical Fitness School, Ft. Benning, GA

3:50 p.m.–4:10 p.m. Physical Readiness Program: U.S. Navy
LCDR René Hernandez, USN, Bureau of Naval Personnel (BUPERS), Washington, DC

4:10 p.m.–4:30 p.m. Assessment of Fitness in the Air Force: Evaluation of the Cycle Ergometry Program
MAJ Sylvia C. Friedman, USAF, Office of the Surgeon General, Bolling AFB, Washington, DC

4:30 p.m.–4:50 p.m. Effect of Alterations in Excess Weight on the Physical Performance of Men and Women
Kirk J. Cureton, University of Georgia, Athens, GA (***unable to attend***)

4:50 p.m. –5:30 p.m. Part III Discussion

5:30 p.m. Closing Remarks
Barbara O. Schneeman

Reception and dinner on the terrace

7:00 p.m.–7:30 p.m. After-Dinner Presentation in the Lecture Room
Zinc and Iron Nutriture: Neuropsychological Function of Women
Harold H. Sandstead, University of Texas Medical Branch, Galveston, TX

Tuesday, September 10, 1996 **Lecture Room**

7:30 a.m. *Breakfast available in the refectory*

8:30 a.m.–8:40 a.m. Opening Remarks
Barbara O. Schneeman

IV. Health Outcomes of Weight Control Behaviors: The Impact on Military Readiness

8:40 a.m.–9:00 a.m. Perspectives on Nutritional Issues of Army Women
LTC Nancy King, USA, Dwight David Eisenhower Army Medical Center, Ft. Gordon, GA

9:00 a.m.–9:20 a.m. Body Weight Satisfaction and Status of Army Women
Carol J. Baker-Fulco, U.S. Army Research Institute of Environmental Medicine, Natick, MA

9:20 a.m.–9:40 a.m. Gender Differences in Food Ration Preferences and Consumption Among Military Personnel
Edward Hirsch, U.S. Army Natick Research, Development and Engineering Center, Natick, MA

9:40 a.m.–10:00 a.m. Health Consequences and Assessment of Disordered Eating and Weight Control Behaviors
David M. Garner, Toledo Center for Eating Disorders, Bowling Green State University, Toledo, OH

10:00 a.m.–10:20 a.m. Part IV (A) Discussion

10:20 a.m.–10:40 a.m. Break

10:40 a.m.–11:00 a.m. Calcium Needs of Pre-Menopausal Women
Richard J. Wood, USDA Human Nutrition Research Center, Boston, MA

11:00 a.m.–11:20 a.m. The Female Athlete Triad: Effects on the Skeleton
Michelle P. Warren, St. Luke's-Roosevelt Hospital and Columbia College of Physicians and Surgeons, New York

11:20 a.m.–11:40 a.m. The Impact of Physical Fitness and Gender-Integrated Training on Risks of Stress Fractures and Other Injuries Among Women in Army Basic Training
COL Bruce H. Jones, USA, U.S. Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Grounds, MD

11:40 a.m.–12:00 p.m. Part IV (B) Discussion

12:00 p.m.–1:00 p.m. Lunch

V. Body Composition and Performance Issues During Pregnancy and the Postpartum Period

1:00 p.m.–1:20 p.m.	Clinical Impact of U.S. Army Policies and Procedures on Pregnancy, the Postpartum Period, and Body Composition: Twenty Years of Experience *Paul N. Smith, COL MC USA (Ret), Tacoma, WA*
1:20 p.m.–1:40 p.m.	The Impact of Pregnancy Weight Restriction, Postpartum Exercise and Weight Loss on Lactation *Megan McCrory, University of California, Davis*
1:40 p.m.–2:00 p.m.	Pregnancy Among Navy Women *CDR Michael J. Hughey, MC USNR, Northwestern University School of Medicine, Wilmette, IL*
2:00 p.m.–2:20 p.m.	Postpartum Fitness *COL Joseph Dettori, USAF, Madigan AFB, Tacoma, WA* (***unable to attend***)
2:20 p.m.–2:40 p.m.	The Impact of Graded Physical Activity Programs on Pregnancy Outcome *CDR E. F. Magann, USN, Balboa Naval Health Center, San Diego, CA* (***unable to attend***)
2:40 p.m.–3:20 p.m.	Part V Discussion
3:20 p.m.	Closing Remarks *Barbara O. Schneeman*

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WORKSHOP ABSTRACTS

The abstracts appear in the order in which they were presented during the workshop on "Assessing Readiness in Military Women: The Relationship to Nutrition," which was held on September 9–10, 1996, in Irvine, Calif.

MILITARY READINESS OF WOMEN: AN OVERVIEW FROM THE COMMAND PERSPECTIVE

CDR Susan B. Herrold, NC, USN, M.N., C.-F.N.P., Bureau of Medicine and Surgery (BUMED), Washington, DC 20372

Military readiness is a broad term that encompasses many elements. A unit's readiness depends on the readiness of the individuals. From a command perspective, readiness encompasses two major components: day-to-day productivity and the ability to deploy.

A unit's deployment readiness can be broken down into three basic categories of preparedness that concern a military commander: physical, mental, and administrative. Members must have the physical and mental stamina required to operate effectively in diverse environments to support military operations. Physical challenges include long hours, irregular and incomplete meals, altered sleep cycles, physical discomforts, and strenuous work. Mental challenges range from intense, stressful work to unrelenting tedium, noise, lack of privacy, lack of control and frustration over lack of supplies, equipment, and communications. And last, members must "have their affairs in order" and be administratively prepared for sudden and lengthy deployments. Administrative details include such things as power of attorney and a valid family care plan.

OVERVIEW OF THE MILITARY WOMAN

Naomi Verdugo, Ph.D., U.S. Army Office of the Deputy Chief of Staff for Personnel, Human Resources Directorate, Washington, DC 20310-0300

The percentage of women in the military currently stands at 13 percent. This represents an upward trend since the start of the All Volunteer Force in both female end-strength and the percentage of female recruits. There are differences in the number and percentage of women across each of the Armed Services. The Air Force has the highest percentage with 16.5 percent of their end-strength comprised of women, while the Marine Corps has the lowest percentage at 4.9 percent. The Army and Navy are similar with 13.8 and 13.4 percent, respectively. The relative percentage of female recruits in each service reflects the percentage of combat and combat-related positions closed to women.

The race and ethnic distribution across each of the services varies. The Air Force has the lowest percentage of minority (non-Caucasian) females, while the Army has the highest percentage. Indeed, African American females comprise the majority group among female enlisted in the Army. The percentage of African American and Hispanic women enlisted recruits

is on an upward trend. Among women who are officers in the Army, 70 percent are Caucasian with the balance being racial or ethnic minorities, but for the other services over 80 percent of the female officers are Caucasian. There is a higher percentage of racial and ethnic minorities among military women than among military men.

Female recruits tend to be a little younger and slightly more educated than their male counterparts, with fewer women having less than a high school diploma. Military recruits are much more likely to be high school graduates than the general U.S. population of the same age group.

Though women are more likely than men to enter the service married, they are less likely to be married at later points in their military career. It appears that women in the military are more likely to divorce than their male counterparts, and once divorced are less likely to remarry. About half of those servicewomen who are married are married to another servicemember.

While the majority of single parents in the military are males, the percentage of females who are single parents far exceeds the percentage of male single parents (ranging from 5–15% of the enlisted males and 12–20% of the enlisted females across services). The gap between males and females in the percentage of single parents is large for enlisted but negligible among male and female officers. Note that the term "single parents" does not necessarily mean custodial parents, but merely refers to a servicemember who is not currently married but who has one or more children with identification cards (that entitle them to certain benefits). Women, more than men, are likely to be custodial single parents.

The drawdown has not reduced the percentage of women in the services, though the overall number of women has declined. The drawdown did result in an aging of the force since the early out incentives were often taken by younger servicemembers.

Data on pregnancy should be more readily obtainable. There is a common perception that women become pregnant to escape deployments, though the few studies I could find on this topic did not bear this out. My analysis shows that military women are significantly less likely to bear a child than their same aged civilian counterparts. This differential becomes even more pronounced if you factor in race-ethnicity as well as age in comparing military and civilian women.

On a spring 1995 Army survey, women reported more difficulty meeting weight standards than did men. As age increased, the difficulty for both men and women increased, but a greater percentage of older women self-reported difficulty meeting weight standards than did older men. Similarly, women were more likely than men to report difficulty meeting the Army PFT than did men (with the exception of junior women officers).

Better data (or at least more access to extant data) are needed on pregnancy to definitively determine the effect of deployment on pregnancy. In general, family and marital status data is of suspect quality. Improvements are especially needed on marital status, particularly divorce which is not tracked except by an occasional survey, the number of children and whether children are custodial or noncustodial, and family data of any kind for the Reserve component.

HEALTH AND NUTRITION PROFILE OF WOMEN IN THE NAVY

Laurel L. Hourani, Ph.D., and Linda K. Trent, M.A., Division of Health Sciences, Naval Health Research Center, San Diego, CA 92186-5122

This overview will draw from three large survey studies of active-duty Navy men and women conducted over the last 12 years. The first, a mailed survey of nutrition knowledge and practices, found that women had better diets and higher nutrition knowledge scores than did men. Knowledge scores were positively associated with healthful dietary choices. Caucasian women reported significantly better diets and higher knowledge scores than did non-Caucasians. While 9 percent of the women exceeded the Navy's percent body fat standard (cutpoint = 30% fat for women), 47 percent of the sample perceived themselves as being overweight, and 60 percent were attempting to lose weight. More non-Caucasians exceeded the body fat standard, yet there was no difference in the percentage of Caucasian and non-Caucasian women who felt that they were overweight. Among those trying to lose weight, Caucasians relied equally on calorie reduction and increased physical activity, whereas non-Caucasians were more likely to diet rather than exercise to lose weight. Feelings of helplessness with regard to eating behavior (e.g., "I have no willpower") were associated with poorer dietary choices. There were no significant differences between the within-standards and out-of-standards groups on nutrition knowledge, overeating, helplessness, or diet scores, though the small sample of overweight women ($N = 23$) might have precluded attaining statistical significance in analyses.

The second study, currently in progress, involves the longitudinal follow-up of several earlier Navy-wide samples, originally surveyed between 1983 and 1989, then contacted again in 1994 if the member was still on active duty. Results for a cohort of 97 women tracked over 10 years revealed that, although there was an increase in mean percent body fat and in the percentage of women exceeding standards, the women's aerobic and muscular fitness had also increased significantly, as measured by age- and sex-adjusted PRT scores for runs and sit-ups. In general, however, a significant negative relationship was observed between percent body fat and PRT performance. Although some researchers have found lean body mass to be a more promising index of military performance than percent body fat, lean body mass was not related to any of the PRT elements in this sample. An overview of the health habits of these women revealed 31 percent smokers and an average weekly intake of 3 to 4 alcoholic drinks. The women were physically active (approximately 1,300 calories expended per week in exercise), and 33 percent received overall PRT rating of excellent or outstanding. Dietary choices favored fruits, vegetables, and grains over meat and dairy products, and healthful food choices over poorer ones. Yet analyses failed to show a relationship between the overall diet score and physical fitness, body composition, medical visits, or self-perceived health.

A third large study, POWR'95, surveyed a representative sample of over 10,000 Navy and Marine Corps men and women. In addition to self-reported dietary behaviors and values, a clinically-based telephone interview of 784 active-duty personnel provided DSM-III, diagnoses of eating disorders. Preliminary analyses showed that both Navy and Marine Corps women had higher scores than men on many positive dietary behaviors such as eating breakfast, taking vitamins, and eating healthier foods; however, they also considered themselves overweight, wanted to lose weight, had tried to lose weight in the past year, had changed their eating patterns

due to a medical condition, took diet pills in the past year, were unsatisfied with their eating patterns, and ate in secret. The combination of the last two items, taken from the *Eating Disorders Inventory*, was shown to be a good predictor of bulimia. Prevalence rates for bulimia of 1.5 and 1.2, lifetime and recent diagnoses, respectively, were obtained with the *Quick Diagnostic Interview Schedule*, with all cases being among women.

CHARACTERISTICS OF FEMALE MIDSHIPMEN: 1992 TO 1996

David W. Armstrong III, Ph.D., (replaced by CDR A. J. Drake III, USN, Ph.D.) Henry M. Jackson Foundation, Endocrinology Division, National Naval Medical Center, Bethesda, MD 20889-5600

Over 4,000 young men and women attend the U.S. Naval Academy. Preparation to become a naval officer occurs in a uniform environment of physical, intellectual, and psychological stress. Female midshipmen experience a significantly greater risk of injury, particularly stress fractures, than male midshipmen. Additionally, women incur a risk of attriting the U.S. Naval Academy 1.3 times that of men, with the majority leaving within the first 120 days.

Beginning in August 1992, we began to investigate the relationship between stress fracture injury and menstrual function. We have recruited more than 250 women to this study and have recently completed 4 years of data collection on women in the graduating class of 1996. Annual measurements have included total bone mineral content and BMD at specific sites by DXA, body composition by DXA, maintenance of individual daily menstrual calendars, physical activity history, PRT data, 24-h dietary recalls, and stress/anxiety measures. Additionally, the commandant's office at the U.S. Naval Academy has collected information on eating disorders form nearly 6,000 midshipmen using Garner's *Eating Disorders Inventory*. We continue to focus our efforts on delineating the contribution of the constellation of various stressors on menstrual dysfunction, bone mineral, and eating disorders or "female athlete triad." Using our study data on menstrual dysfunction and BMD and that of the *Eating Disorders Inventory*, we are pursuing the development of a female stress triad risk model for stress fracture injury.

The results of our work with female midshipmen include:

1. Psychological and physiological stress markers are elevated.
2. Percent body fat increases as food calorie consumption decreases.
3. Approximately 15 percent of female midshipmen experience significant and recurring menstrual irregularity.
4. Over 4 years, median calcium intake is 900 mg/d, well below the Recommended Dietary Allowance.
5. Calcium intake prior to entry into the U.S. Naval Academy is highly correlated to total bone mineral content but not 2 years later.
6. Symptoms of eating disorders as measured by the *Eating Disorders Inventory* rise to 11 percent of female midshipmen from 5.5 percent at entry to the U.S. Naval Academy.
7. Use of oral contraceptives appears to provide protection from loss of bone mineral.
8. Female midshipmen do not appear to differ for weight, percent body fat, and fitness compared to civilian college age women.

9. Total bone mineral content and cortical BMD increase during a midshipman's tenure at the U.S. Naval Academy regardless of menstrual status.

10. Oligomenorrhea appears to be associated with loss of BMD in the trabecular bone of the hip.

11. Stress fractures of the tibia appear to be associated with increased tibial BMD.

12. Stress fractures of the tibia are associated with decreased BMD of the spine and hip but not total bone mineral content.

We are continuing our efforts to link alterations in the reproductive axis, change in bone mineral and disordered eating behaviors with stress fracture injury in U.S. Naval Academy female midshipmen.

HEALTH, FITNESS, AND NUTRITION AMONG MILITARY WOMEN AND MEN

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The percentage of women in the military has increased from under 10 percent in the 1980s to about 14 percent in 1995. This change is in response to the shift from a conscription-based to an all-volunteer force as well as increased acceptance of women's involvement in traditionally male-dominated occupations in the military. The increasing involvement of women in the military coupled with changes in the nature of that involvement has raised questions about military women's health, safety, and well-being and the implications of these issues for overall military readiness.

In this paper, we consider data on health, fitness, and nutrition among military women and men from the 1992 and 1995 worldwide *Surveys of Health-Related Behaviors among Military Personnel*, the two most recent surveys in the series conducted between 1980 and 1995. Both surveys used similar methods in which military personnel, under the direction of civilian data collection teams, completed self-administered questionnaires in group sessions at installations across the world. In 1992 the sample was comprised of 1,948 women and 14,447 men; in 1995, the sample contained 2,974 women and 13,219 men. From these data we examine health status, health practices, food consumption behaviors, health risk perceptions, and behavior changes from awareness of potential or actual health problems.

Findings show that:

- the demographic composition differs among military women and men—specifically, military women are more likely than men to be younger, African American, somewhat better educated, and single;
- military women are more likely than military men to report poorer health and more days of restricted activity from physical or mental health problems;
- both women and men are aware of risks of poor health practices, but differ in the likelihood of engaging in these actions; women are less likely than men to be substance users, but also

less likely to engage in healthy behaviors such as strenuous exercise and eating at least two meals a day; women are also less likely than men to eat high cholesterol foods; and

- both military women and men who have high blood pressure or who are overweight follow medical advice; fewer women and men change smoking or exercise habits when advised to do so.

The findings regarding poorer health among military women than men are generally consistent with those from civilian studies. Although the differences are statistically significant, they are not large. Substance use is less likely to affect the work performance of military women than military men, but military women are less likely to engage in other sound health practices associated with productivity at work. These findings suggest areas where education and intervention efforts to improve health might be profitably directed.

DISORDERED EATING AMONG WOMEN IN THE ARMED FORCES

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Disordered eating patterns and behaviors among women in the Armed Forces may seriously compromise military readiness. Furthermore, these problems may significantly impair the servicewoman's ability to effectively respond to stressors inherent in deployment or in military operations that occur under demanding conditions. The literature on the prevalence of disordered eating in the military is almost nonexistent. It is known that there is a high prevalence of disordered eating patterns and behaviors in the general population. Studies indicate that between 10 and 75 percent of women are dieting, dissatisfied with their body size, or unhappy with their perceived body image. The prevalence of diagnosable eating disorders ranges from 1 to 6 percent. Chronic dieting, dysfunctional beliefs, and self-destructive attitudes concerning body size and weight maintenance are indicators of "subclinical" issues that may be precursors to the development of eating disorders. Just as importantly, these subclinical issues may be compromising in their own right. The large literature generated from the Army's Nutrition Research Center addressing the impact of poor nutrition and ideal weight on physical fitness at least indirectly supports the occurrence of disordered eating and its detriment to military readiness. Although the prevalence of disordered eating among military women has not been thoroughly characterized, it is likely to be prevalent because the military culture place importance on factors that are known to be of etiological significance in the development of eating disorders. These factors include appearance, weight control, exercise, and perfectionism. Therefore, the military may be considered to have occupational risk factors that may exacerbate or contribute to the development of disordered eating patterns and behaviors and similarly precludes identification of the problem.

BODY COMPOSITION AND PHYSICAL PERFORMANCE OF WOMEN

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The presentation provides an overview of relationships between body composition elements and performance of physical tasks, and explores gender differences in these relationships. A review of body composition analysis was provided. A two-compartment model in which the body is divided into fat and fat-free masses was used as the basis for discussion in this paper. Relationships between body compartment masses and lifting and carrying tasks were explored. Lifting and carrying are the most common physically demanding tasks in the military. They differ from one another in that the body mass is moved in carrying tasks, whereas the body mass is not part of a lifting task. Women have a lower muscle mass, on average, than men, and the distribution of this mass differs between genders. It was hypothesized that (1) the magnitude of the fat mass would be negatively associated with work capacity for tasks that involve movement of the body; (2) women, having less fat-free mass than men, have a smaller work capacity, on average; and (3) differences in the distribution of muscle mass between genders will lead to a difference in the physical performance-fat free mass relationship between genders. Analysis of data collected from 62 male and 38 female Navy personnel revealed fat-free mass, but not fat mass, was related to maximal box lifting capacity ($r^2 = 0.71$) and strength measures (typical $r^2 = 0.66$); and fat-free mass was positively associated and fat mass negatively associated with box carrying capacity ($R^2 = 0.40$) and running performance ($R^2 = 0.55$). Men performed better, on average ($p < 0.05$), than women on all tasks. When body composition variables were used to predict performance, gender did not account for any additional variance. Furthermore, there was no gender interaction with body composition in the prediction of physical performance. There appear to be no gender differences in the relationships between body composition variables and physical task performance. Differences in physical performance between genders are related to differences in body composition.

METHODOLOGICAL PROBLEMS IN THE ASSESSMENT OF WOMEN'S BODY COMPOSITION BY THE MILITARY: IDENTIFICATION OF VALID AND RELIABLE METHODS FOR FIELD USE

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Weight standards have been used in the U.S. military for over a century and have been applied to selection of female servicemembers since they were first applied as upper weight limits in World War II. Today, all of the services have body fat limits for men and women, and retention in the military depends on meeting these standards. The stated goals of the regulations vary across services, but all include some mix of physical fitness/job performance, long-term health, and military appearance.

A DoD directive specifies that all services will use circumference-based equations to assess body fat in overweight servicemembers to enforce weight control regulations. The intent of this directive is to distinguish between those individuals who are overweight because of excess

adiposity and those who exceed the normal range for muscularity. The upper limits of fatness originally recommended as appropriate standards were 20 and 30 percent body fat for men and women, respectively. Body fat standards vary between services and, in some services, by age; however, the services are consistent in recognizing that there is a gender-appropriate level of body fat that is higher in women.

The methods of body fat estimation using circumference-based equations also vary between services. While the equations are similar for males and consistently include waist girth adjusted by neck girth, the female equations differ considerably. Each of the female equations, derived by multiple regression from military populations by comparison to hydrostatic weighing, emphasizes different sites of typical fat deposition females, including upper arm and thigh (Marine Corps), hips and waist (Navy), and hips (Army) alone. Two comparisons of the various circumferential methods to criterion methods (hydrostatic weighing or DXA) suggest that none of these female equations substantially improves the prediction of adiposity over that of BMI, and body weight is superior in predicting DXA-assessed changes in fat. The BMI that corresponds to the upper limit of 30 percent body fat for young women is 24 kg/m^2. These data suggest that a gender-fair weight control assessment could be limited to weight (or BMI) for women. Usually only those soldiers who are overweight are assessed for body fat; however, they must meet the fat standard to be removed from the weight control program. Thus, the inadequacy of female body fat prediction and prediction of change should be a critical concern. Because of a greater variability in muscularity in men, a circumferential-based fat estimation should continue to be used to distinguish overweight men with excess fat from men with extraordinary levels of lean mass.

Setting standards that are different for men and women is a sensitive issue in the services; however, it is generally accepted that body composition standards are important to ensuring military readiness. Although a relationship can be demonstrated between percent body fat and aerobic capacity, this is a relatively weak relationship. There is no relationship between maximal lift capacity or other strength measures and adiposity. Thus, as noted in the Committee on Military Nutrition Research report on *Body Composition and Physical Performance*, body fat standards do not efficiently *select* for physical performance. By motivating regular fitness activity and good nutrition, body fat standards are used to *promote* physical fitness habits. Generalized fitness testing alone is inadequate to ensure optimal fitness. Body composition standards complement fitness testing in the shared objective of maximizing fitness. Body composition measures are more stable than physical performance tests, with passive measurements which reflect longer-term health and fitness habits. Gender-neutral fat standards set to a level appropriate to males would substantially compromise the health and fitness of servicewomen because of their gender-appropriate fat which is in greater proportion to total weight and is situated in more locations for more complex physiological roles. Biologically inappropriate fat standards for women impair rather than enhance military readiness. Gender-appropriate body fat and/or body weight standards combined with an appropriate level of support to the individual (e.g., physical training programs, dietary counseling, and well-equipped fitness facilities) should enhance physical readiness of all soldiers.

ETHNIC DIFFERENCES IN BODY COMPOSITION: APPLICATION TO ACTIVE MILITARY WOMEN

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Background

Research suggests that there is a strong link between ethnicity and body composition, with documented differences in the composition of the fat-free body. Thus, ethnic variation needs to be considered when assessing body composition of women from diverse ethnic groups serving in the U.S. military.

To assess body composition, body weight is typically subdivided into fat and fat-free body compartments. The fat consists of all extractable lipids, and the fat-free body includes water, protein, and mineral (Siri, 1961). This two-component model assumes that the: (1) densities of fat and the fat-free body components are respectively, 0.901 g/cc (grams/cubic centimeter) and 1.100 g/cc, and these densities remain constant and are the same for all individuals, (2) respective densities and relative proportions of the fat-free body components, water (0.9937 g/cc; 73.8%), protein (1.34 g/cc; 19.4%), and mineral (3.038 g/cc; 6.8%) are constant within and among individuals, and (3) individuals being assessed differ from the reference body only in the amount of fat (Brozek et al., 1963; Siri, 1961). Using two-component equations of either Siri (1961) (percent body fat = [4.95/Db – 4.5] × 100) or Brozek et al. (1963) (percent body fat = [4.57/Db – 4.242] × 100), total body density from hydrostatic weighing can be converted to relative proportions of body fat (percent body fat).

Generally, two-component model equations provide accurate estimates of percent body fat as long as the basic assumptions of the model are met. However, researchers have reported that fat-free body density varies with ethnicity, depending mainly on the relative proportion of water and mineral comprising the fat-free body (Wang et al., 1989).

Fat-Free Body Composition of African American Women

Research demonstrates that African American women have relatively greater skeletal muscle mass, bone mineral mass, and bone density than Caucasians (Cohn et al., 1977; Ortiz et al., 1992). Thus, the estimated density of the fat-free body is 1.106 g/cc for African American women.

Although the relative hydration of the fat-free body is similar for African Americans and Caucasians (~74%), the relative mineral content in the fat-free body of younger (7.8%) and middle-aged (7.5%) African American women is somewhat higher than that of their Caucasian counterparts (7.3% and 6.7%, respectively, for younger and middle-aged Caucasian women) (Cote and Adams, 1993; Oritz et al., 1992). Also, the average bone mineral density of African American women (1.18 to 1.25 g/cm^2) is significantly greater than that of Caucasian women (1.09 to 1.16 g/cm^2) (Cote and Adams, 1993; Ortiz et al., 1992).

Fat-Free Body Composition of Native American Women

McHugh et al. (1993) found that the average bone mineral density (1.18 g/cc) of Native American women was significantly greater than age-matched reference data. The average relative total body mineral of Native American women was 8.1 percent of the fat-free mass, compared to 6.8 percent fat-free body assumed for the reference body. Based on this value, the density of the fat-free body for Native American women was estimated to be 1.108 g/cc.

Fat-Free Body Composition of Asian Women

Using the average total body water and FFM value reported by Wang et al. (1995), the relative hydration of the fat-free body was 78.3 percent for Asian women. This value indicates that the relative water content of the fat-free body of Asian American women is greater than the assumed value for the reference body (73.8% fat-free body).

Based on average bone mineral content (BMC) value reported for younger, middle-aged, and older Japanese Native adults, the relative mineral composition of the FFM was 8.6 percent for younger and middle-aged women and 6.6 percent for older women (Tsunenari et al., 1993). Compared to other ethnic groups, the relative mineral content of the fat-free body in younger and middle-aged Japanese women is higher and reflects a smaller FFM (34 kg) and higher fat content (32 and 36% body fat) for this population subgroup. Assuming a relative FFM hydration of 73 percent, the estimated density of the fat-free body is approximately 1.111 g/cc for younger and middle-aged women and 1.105 g/cc for older women.

Fat-Free Body Composition of Hispanic Women

Heyward and Stolarcyzk (1996) reported that the average total body BMD, BMC, total body mineral, and total body water of premenopausal Hispanic women were, respectively, 1.161 g/cm^2, 2.41 kg, 3.08 kg, and 30.1 liters. Also, the relative mineral content was 7.4 percent fat-free body. Comparison of Siri's two-component model and Friedl's four-component model that adjusts body density for body mineral and body water yielded significantly different estimates of percent body fat for the Hispanic women in this sample (26.9% and 30.6% body fat, respectively). These data suggest that the fat-free body density of Hispanic women is greater than the assumed value for the reference body (1.10 g/cc). In fact, the density of the fat-free body of Hispanic women in this sample was estimated to be 1.105 g/cc using a fat-free body-mineral content of 7.4 percent and fat-free body-water content of 72.8 percent.

Fat-Free Body Composition of Caucasian Women

Research demonstrates that the bone mineral density and relative mineral content of the fat-free body of Caucasian women is 1.16 g/cm2 and 6.7 to 7.3 percent fat-free body, respectively. Also, the relative hydration of the fat-free body is estimated to be 74.2 percent fat-free body (Cote and Adams, 1993; Hansen et al., 1993; Ortiz et al., 1992). Thus, the average fat-free

body density in younger and middle-aged women (1.097 g/cc) is somewhat less than the assumed value for the reference body.

Conclusions and Recommendations

In summary, research clearly demonstrates that fat-free body composition is influenced by ethnicity. The average fat-free body-density for Native American, African American, Asian, and Hispanic women is greater than 1.100 g/cc; therefore, prediction equations based on two-component models will systematically underestimate the relative body fat of women in these ethnic groups by 2 to 4 percent body fat, on average. On the other hand, the fat-free body-density of Caucasian women is less than 1.100 g/cc and their percent body fat will be systematically overestimated by approximately 1 to 2 percent body fat, on average. Therefore, when estimating relative body fatness from total body density, ethnic-specific conversion formulas need to be used to derive a more accurate estimate of percent body fat for women in the military (Table A-6).

TABLE A-6 Ethnic-Specific Formulas for Conversion of Body Density (Db) to Percent Body Fat (BF) for Women

Ethnic Group	Age (years)	BF (%)	Fat-Free Body (g/cc)
Native American	18–60	(4.81/Db)–4.34	1.108*
African American	24–79	(4.85/Db)–4.39	1.106†
Hispanic	20–40	(4.87/Db)–4.41	1.105‡
Asian	18–48	(4.76/Db)–4.28	1.111§
Caucasian	20–80	(5.01/Db)–4.57	1.097‖

* Assumes water and protein proportions are 7.3 percent and 18.9 percent, respectively. Measured mineral was 8.1 percent fat-free body (Hicks, 1992).

† Assumes protein proportion is 19.2 percent. Measured mineral was 7.8 percent fat-free body and water was 73 percent fat-free body (Ortiz et al., 1992).

‡ Assumes protein proportion is 19.8 percent. Measured mineral was 7.4 percent fat-free body and water was 72.8 percent fat-free body (Stolarcyzk et al., 1995).

§ Assumes water and protein proportions are 73 percent and 18.4 percent, respectively. Measured mineral was 8.6 percent fat-free body (Tsunenari et al., 1993).

‖ Assumes protein proportion is 18.6 percent fat-free body. Measured mineral was 7.2 percent fat-free body and water was 74.2 percent fat-free body (Cote and Adams, 1993; Hansen et al., 1993; Ortiz et al., 1992).

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CROSS-SECTIONAL PROFILE OF BODY COMPOSITION AMONG ACTIVE-DUTY NAVY AND MARINE CORPS PERSONNEL

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POWR'95 was designed to provide baseline health and risk factor information to estimate the prevalence of a wide range of physical and mental health conditions and to make relevant comparisons both within military subpopulations and between military and civilian populations. The three components of POWR'95 consisted of self-report questionnaires that were mailed to approximately 25,000 randomly-sampled active-duty Navy and Marine Corps personnel, physical measurements that were taken on 1,300 subjects who participated in the survey, and a

clinically-structured telephone interview that addressed issues of mental health with approximately 800 active-duty personnel.

The specific objective of POWR'95, as is addressed here, is to provide baseline information on the anthropometric characteristics of women and men in the Navy and Marine Corps. POWR'95 used noninvasive, standardized procedures and collected data on blood pressure; heart rate; height, weight, neck, waist, and hip circumferences; triceps and subscapular skinfolds; and handgrip strength. This presentation will focus on measures of body composition. The measures used in this study included (1) BMI or the ratio of a person's weight in kilograms to the square of the person's height in meters; (2) prevalence of overweight based on BMI; (3) percent body fat predicted from generalized equations using circumference measurements and height; (4) percent body fat estimated by circumferences, age, and height; and (5) percent exceeding current standards for body fat established by the Navy and for height/weight indices used by the Marine Corps. Use of the BMI as an overall indicator of obesity for the civilian population has been endorsed by the National Institutes of Health Consensus Development Panel (1985). The Department of the Navy currently uses circumference-derived percent body fat to ascertain fitness for continued duty as part of their PRT evaluation. Generalized equations based on girth measurements are commonly used to determine body fat in many special population studies. Preliminary analyses of the body measurement data include descriptive statistics on each of the indices of body fat/body mass and on the prevalence of overweight and over-standard by gender, race, and age. Attention is give to branch of service comparisons and to comparisons between BMI and the two circumference-based body fat measures.

ACCESSION WEIGHT STANDARDS: INCONSISTENCIES AND GENDER BIAS

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The increasing number and role of women in the military demand review of the differences in qualification rates for accession and allowable weight limits between males and females. Height and weight accession tables for the military services are characterized by wide variations. Their origins are largely unknown or based on arbitrary standards, lacking a scientific or medical basis. In comparing the weight standards for men with those for women, inconsistencies are noted. Using a regression formula to calculate an estimated percent body fat using height and weight, it was shown that the current standards allow many men and women to enter the military at weights that exceed the service-specific body fat percentage limits. Additionally, bias in these weight standards is noted, with men judged qualified for accession at weights further from their ideal weight than those for women. In an analysis of data from the NHANES III, a significantly higher percentage of women than men aged 18 to 24 years would be disqualified for weight if they attempted to enlist.

ARMY PHYSICAL FITNESS PROGRAM

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The Army PFT is the commander's tool for measuring minimum physical fitness of all soldiers, regardless of military occupational specialty (MOS) or component. When applied to a command, the Army PFT results show a unit's overall level of physical fitness and provide a basis for determining training requirements and planning programs to address shortcomings. A passing score on the Army PFT suggests that soldiers possess the minimum fitness level to complete mission essential tasks successfully.

The Army PFT is a three-event test requiring no equipment so that it can be conducted in any setting, including the field. The events are push-ups and sit-ups (conducted in a 2-min time period) and a 2-mi run for time.

The U.S. Army Physical Fitness School was tasked by the Army chief of staff in 1994 to conduct an Army PFT update study to ensure the Army PFT measures baseline levels of physical fitness throughout the Army, to provide scientific review of Army PFT standards, and to seek gender equity ("equal effort" by both genders to achieve the same point scores on the test).

The study was conducted in conjunction with U.S. Army Research Institute of Environmental Medicine, U.S. Army Research Institute, and the AMEDD using a random sample of 2,588 personnel representing all age groups, both genders, and all MOSs.

Overall, the present force is more fit than in 1984 with great strides made by females. Half the career female soldiers (aged 26 and older) maxed the 2-mi run (twice the ratio of career males). Females' sit-ups were within 3 percent of males across all age groups. Recommendations include setting the same standards for both genders in the sit-up and generally toughening up the female run times. These new standards will "level the playing field" between the genders.

This study gives us confidence about what women can do and validates that we should not "dumb it down" when it comes to female readiness standards. The more we say women are "different," the harder it will be on the system. Tough, consistent battle-focused physical training is the key to weight reduction and body fat loss. Soldiers without weight problems are usually found with units who do tough, realistic, battle-focused physical training. Most Army TO&E (Table of Organization and Equipment) units conduct physical training 5 d/wk in order to ensure soldiers can meet mission requirements. For example, both men and women need to have the confidence in their ability to lift an unconscious comrade and drag him or her to safety, which could also include lifting them 4 ft off the ground to place on the back of an ambulance. Meeting weight standards alone may not necessarily enable a soldier to meet performance goals. The proposed tougher Army PFT standards will help soldiers lose weight in healthy ways.

PHYSICAL READINESS PROGRAM, U.S. NAVY

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In June 1981, the DoD first released Instruction 1308.3, "Physical Fitness and Weight Control Programs," requiring that all services have a physical fitness program for servicemembers, and a testing procedure to evaluate the efficacy of their program. The Navy Health and Physical Readiness Program was established in response to this mandate.

The Navy Health and Physical Readiness Program requires that all servicemembers participate in physical exercise three times per week and that they be tested twice annually. The fitness testing portion of the Navy Health and Physical Readiness Program is the PRT. The Navy PRT includes evaluation of body composition and physical fitness. If members fail any portion(s) of the PRT three times in a 4-y period, they may be administratively separated from the Navy.

For the body composition evaluation, each member is first screened by a height-weight standard (from DoDI 1308.3, updated in 1995). If their weight is within the upper limit, they are "within standards;" if they fail, they must be evaluated using the Navy circumference measurement (SE = ± 3.5%) technique (OPNAVINST 6110.1D, 1990), developed by the Naval Health Research Center in San Diego, California. If the member is within the upper limit of body fat (currently, 22% for males and 30% for females), they are considered "within standards."

The fitness portion of the Navy PRT evaluates aerobic fitness, muscular endurance, and flexibility. Aerobic fitness is measured by a 1.5-mi run (or 500-yd swim); muscular endurance is measured by a 2-min push-up test and a 2-min curl-up test; flexibility is measured by a sit-reach test (OPNAVINST 6110.1D, 1990).

Pregnant servicemembers are exempt from the Navy PRT and body composition measurements from the time of medical diagnosis of pregnancy to 6 months following delivery (this can be extended by a physician). Except when contraindicated, pregnant members are expected to participate in an exercise program on the advice of their physician approved by the American College of Obstetricians and Gynecologists.

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ASSESSMENT OF FITNESS IN THE AIR FORCE: EVALUATION OF THE CYCLE ERGOMETRY PROGRAM

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Now more than ever, our smaller, deployable force requires the highest level of health and fitness. Since 1992, the Air Force has utilized submaximal cycle ergometry to safely estimate the maximal amount of oxygen consumed ($\dot{V}O_2max$) at maximum exercise. $\dot{V}O_2max$ defines maximal aerobic capacity, which is an important indicator of the ability to perform sustained muscular work, fitness, cardiovascular health, and decreased mortality. The Cycle Ergometry Program is critical in educating our active-duty population in the positive health effects of aerobic exercise and its impact on total health.

The speaker will present an overview of the program, highlighting its history and implementation. In addition, the speaker will address the program's future goals.

The speaker will present an overview of the program, highlighting its history and implementation. In addition, the speaker will address the program's future goals.

I. History of Fitness in the Air Force
II. Goals and Mission
III. Cycle Ergometry
    a. Improvements
IV. Fitness Program Office
V. Critical Program Personnel
VI. Assessment Process
    a. Administrative Issues
VII. Future Research and Vision

EFFECT OF ALTERATIONS IN EXCESS WEIGHT ON THE PHYSICAL PERFORMANCE OF MEN AND WOMEN

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I will discuss the results of studies that we have done to quantify the effects of alterations in excess weight on physical performance in men and women. These studies provide experimental evidence that strongly suggest that the relationships between body fatness and physical performance described in cross-sectional studies are cause and effect. In addition, several of the studies attempt to directly determine the extent to which the sex difference in certain physical performances is related to the sex difference in percentage fat. The data provide insight into the importance of body fatness as a factor affecting physical performance of women in relation to that of men.

ZINC AND IRON NUTRITURE: NEUROPSYCHOLOGICAL FUNCTION OF WOMEN

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This work is being done in collaboration with Nancy W. Alcock, Ph.D.; Hari H. Dayal, Ph.D.; Norman G. Egger, M.D.; and V. M. S. Ramanujam, Ph.D., from our department, and James G. Penland, Ph.D., of the USDA-ARS Human Nutrition Research Center in Grand Forks, N.D., and Katsuhiko Yokoi, M.D., Ph.D., of the Department of Social Medicine, University of Kyoto Medical School, Kyoto, Japan.

Our work is in progress. We are testing the hypothesis: zinc and iron repletion will improve neuromotor and cognitive functions of young women. Our study is based on the common occurrence of mild iron and zinc deficiencies among young women and the essentiality of iron and zinc for cognition.

Due to a decrease in consumption of red meat, the average intake of iron and zinc of young U.S. women decreased 40 percent from 1977 to 1985 (Briggs and Schweigert, 1990). This change in food choice accounts for the median iron (9.8 mg) and zinc (7.4 mg) intakes found by NHANES II (Murphy and Calloway, 1986), which were 69 and 59 percent of the calculated need at 20 percent bioavailability (Halberg and Rossander-Hultén, 1991; King and Turnland, 1989). Reflecting low iron intakes, the 25th percentile for serum ferritin was 14 μg/L, a level at which bone marrow iron is absent (Halberg and Rossander-Hultén, 1991).

It was found through regression analysis of food frequency data that red meat was one of five predictors of serum ferritin concentration in young women ($N = 38$, $R^2 = 0.53$, $p = 0.0001$) and one of four predictors of zinc status, as indicated by the plasma zinc disappearance constant (k) ($N = 19$, $R^2 = 0.63$, $p = 0.005$) (Yokoi et al., 1994).

In our study, zinc status and serum ferritin concentrations were related (Yokoi et al., 1994). Serum ferritin was lower when plasma zinc was less than 70 μg/dL ($p < 0.03$) in 18 subjects in whom the disappearance of injected ^{67}Zn from plasma was measured, and plasma zinc disappearance and plasma zinc turnover were increased when serum ferritin was less than 20 μg/L ($p < 0.05$ and 0.01). When plasma zinc concentration was < 70 μg/dL, the disappearance of injected ^{67}Zn was increased ($p < 0.05$). Regression analysis found that serum ferritin concentrations and the 30- to 60-min disappearance of injected ^{67}Zn were inversely and nonlinearly related ($N = 18$, $R^2 = 0.777$, $p < 0.0003$). The nonlinearity was probably caused by an increased intestinal absorption of zinc as iron status decreased (Pollack et al., 1965).

The essentiality of iron for human neuropsychological function was suggested 75 years ago (in retrospect) by findings in children with hookworm (International Health Board, 1919; Waite and Nelson, 1919). More recently, iron status was related to cognition of children (Oski and Honig, 1978; Pollitt et al., 1982; Webb and Oski, 1973), and to EEG power and lateralization, and cognition of young adults (Tucker et al., 1984).

The essentiality of zinc for human cognition was shown by experimental deficiency (Henkin et al., 1975; Penland et al., 1997) and repletion (Penland, 1997; Sandstead, 1992) studies. A recent double-blind randomized depletion-repletion study of 11 men found abnormal neuromotor, attention, perception, short-term visual memory, and spatial functions (p <0.05)

after 35 days of depletion when 1, 2, 3, or 4 mg zinc per 2,500 kcal were fed daily, as compared to function when 10 mg was fed (Penland et al., 1997). Consistent with the findings in men, an 8-wk double-blind randomized controlled trial of zinc repletion in 17 women with serum ferritin concentration less than 20 μg/Liter found improved ($p < 0.004$) short-term visual memory (Wechsler, 1981) in 11 subjects given 30 mg zinc plus selected micronutrients daily and no improvement in 6 women given micronutrients alone (Sandstead, 1992). A recent 10-wk double-blind randomized controlled repletion trial in urban first graders (6–9 years) from Chongqing, Qingdao, and Shanghai, China, found that zinc repletion with or without selected micronutrients improved key tapping, circular tracking, matching complex designs, visual memory of complex designs, and concept formation measured by recognition of oddity, while micronutrients alone did not ($p < 0.05$) (Penland, 1997).

The study we are doing that is of relevance to military women or young women is a 16-wk double-blind randomized controlled repletion trial of 30 mg iron or 30 mg zinc daily and/or selected micronutrients alone, with a crossover at 8 weeks, on neuropsychological functions of 60 nonanemic women, ages 19 to 40 years, who have serum ferritin concentrations ranging from 5 to 18μg/Liter. Zinc status is being characterized by ^{67}Zn kinetics and white blood cell zinc concentrations. Twenty women with serum ferritin greater than 30 μg/Liter serve as normal controls. Measurements of neuropsychological functions are done using a computerized task battery developed by James G. Penland. In 2 years we will know the outcome.

This study has important implications for military women. Job performance often requires optimal neuropsychological function. If the hypothesis is proven true, dietary recommendations will need to be revised to assure that intakes of bioavailable iron and zinc are sufficient to meet the needs of women. On a broader scale, this study has implications for all persons at risk for iron and zinc deficiencies. If it is found that neuropsychological functions are improved by iron and/or zinc repletion, dietary guidelines and feeding programs for groups at risk will need to be revised to assure that intakes of bioavailable iron and zinc are adequate. Research will be needed to learn how iron and zinc affect human cognition throughout the life cycle.

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PERSPECTIVES ON NUTRITIONAL ISSUES OF ARMY WOMEN

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Between 1980 and 1993, 278 female soldiers participated in six military nutritional studies. However, the first study specifically designed to determine the nutritional intake of female soldiers was conducted in 1993 in Fort Jackson, South Carolina (King et al., 1994). The adequacy of nutritional intake was assessed using the MRDAs. Lower nutritional intakes were more often seen in the field studies than in the dining hall studies, for energy, protein, calcium, iron, vitamin B_6, and folic acid. Even though mean nutritional intakes in the dining hall studies were marginal at worst, some soldiers had mean intakes of less than 60 percent of the MRDA. For instance, in the 1993 Fort Jackson study, 31 out of 49 soldiers consumed less than 70 percent of their calcium requirement. The two main reasons given for not eating more were "not being hungry" and "being too full," suggesting that female soldiers may not be able to eat as much as required to meet their nutritional requirements. Therefore, the nutrient density of the menu plays a significant role in low nutrient intakes. These low intakes are similar to the intakes reported in national nutritional surveys for the U.S. general female population ages 20 to 29 years. This suggests that the nutritional problems of military women may not be different from those of their civilian counterparts. However, the nutritional problems of military women may be exacerbated by the physical performance demands imposed by military training and the need to meet weight-

for-height and body fat standards. It appears that the potential for nutritional deficiencies among military women exists and further research is needed. Nutritional surveys of actual food consumption are crucial to the quantitative determination of food intake and assessment of nutritional status of military women. More research is needed to ascertain the short- and long-term effects of sporadic and routine suboptimal intake on nutritional status, health, and performance of military women. Considering that approximately 54 percent of the women in the U.S. Army are older than 25 years of age, particular emphasis should be given to including older military women in future studies. Further, nutrition education is crucial to motivate military personnel to select diets and adopt eating habits consistent with current knowledge relative to healthy eating practices.

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BODY WEIGHT SATISFACTION AND STATUS OF ARMY WOMEN

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Questions that ask about body weight, weight satisfaction, and weight change have been incorporated into many of the questionnaires administered during studies conducted by the Military Nutrition Division and other divisions of U.S. Army Research Institute of Environmental Medicine. This overview draws from the few studies that gathered this information from a substantial number of Army women.

The only randomized mail survey conducted by the Military Nutrition Division is reported by M. S. Rose et al. (1993) in the technical report entitled, "Weight Reduction Techniques Adopted When Weight Standards are Enforced." Unfortunately, there was an extremely poor response rate (26.3%) to this survey, and the report was not widely circulated. However, the information obtained from this survey is informative. Of the 1,069 correctly completed questionnaires, 189 (17.7%) were from women. Women composed 11.1 percent of the total Army at the time of the survey. The female respondents were 31.3 ± 7.1 (mean ± SD) years of age (range: 18–52 years), 65.1 ± 2.7 inches (58.5–72.0) tall, and weighed 134.6 ±16.7 lb (100–185). The technical report does not report the proportions of enlisted and officers by gender.

When asked if they had ever attempted to lose weight, 144 (76%) of the women responded yes. Sixty-two percent of these women reported gaining weight since entering the Army. Almost half of the weight gainers had gained more than 10 lb. Although most women gained weight after entering the Army, 35 percent of the women weighed less at the time of survey than they did when they entered the Army. Very few women seem to be able to maintain a stable body weight; 86 percent of the women reported a difference of greater than 10 lb between their maximum and minimum adult weights.

Most women desired to weigh less than they did. While most women were within 10 lb above their desired weight, one-third of the women weighed more than 10 lb above their desired weight. Women's desired body weights were well below the maximum allowable weights of the Army Weight Control Program. Only eight women (4%) wanted to weigh more than their height and age specific screening table weight. Almost one-third of the women wanted to weigh greater than 20 lb less than their screening table weight. Although the data were not broken down by gender, the fact that 73 percent of men and women were attempting to lose weight suggests that a large proportion of women would have been actively trying to lose weight at the time they completed the survey. Although 40 (32%) of all female respondents weighed more than their height and age specific maximum allowable weight, only 16 (8.5%) were enrolled in the Army Weight Control Program at the time of the survey.

As part of a large nutrition assessment study conducted by Mary Klicka and colleagues (1993) at the U.S. Military Academy, West Point, 89 female cadets completed a background questionnaire that included questions dealing with body weight satisfaction. Mean age of cadets was 20.1 ± 1.5 years (18–25). Seventy-nine percent of the female cadets were trying to lose weight at the time of the study. Twenty-one percent were satisfied with their current weight, while no female cadet was trying to gain weight.

In a study of women in enlisted basic training, LTC Nancy King and colleagues (1994) administered a similar background questionnaire to 175 women. Mean age of the enlisted women was 21.4 ± 3.43 years (17–33). Heights ranged from 59–74 inches with a mean of 64.9 ± 2.55 inches; weights were 99–193 lb, mean 135 ± 19.2 lb. Sixty percent of the enlisted female recruits reported they were trying to lose weight. Sixty-seven percent of the women in basic training had lost weight in the prior year, while 69 percent had gained weight. Thirty-four percent of these women reported both losing and gaining weight during the prior year. Unlike the U.S. Military Academy cadets, almost 10 percent of the enlisted female recruits were trying to gain weight.

The largest survey of Army women to date has been performed under two Defense Women's Health Research Program protocols headed by CPT Anthony Pusateri and LTC Alana Cline. Questionnaires were completed by 1,216 women from four army installations. Study populations included women entering enlisted basic training (N = 159), enlisted women in Advanced Individual Training (AIT) (N = 316), enlisted women with at least 1 year of military experience (N = 538), women attending the Officer Basic Course (N = 45), and officers with military experience (N = 119). Questionnaires from 39 women were missing military group information and, therefore, were not included in group analyses.

Ages ranged from 18 to 52 years. Mean age was 26.5 ± 7.5 years. Self-reported height and weight were 65.1 ± 3. 0 inches and 140.1 ± 19.9 lb, respectively. The women, on average, responded that they would like to weigh 10 lb less than their current weight; however, almost 10 percent gave a desired weight greater than their current weight and 9 percent liked the weight they were at. Although 81 percent of the women wanted to lose weight, only 61 percent of the women indicated they were actually trying to lose weight at the time of the survey. Sixty-three percent of the women responded that they had lost weight in the prior year. The mean reported weight loss was 11.2 ± 7.9 lb. Eight percent of the women reportedly lost 25 lb or more. Conversely, 65 percent of women said they gained weight the prior year. The mean reported weight gain was 10.6 lb ± 8.0 lb. Almost 7 percent of the women said they gained 25 lb or more. Only 12 percent of women were weight stable in the year prior to the survey. Forty-one percent

said they both lost and gained weight. Of women who reported both losing and gaining weight during the prior year, 36 percent ended up back where they started, and 38 percent gained more weight than they lost. The average net weight change was + 0.7 lb. The group of women entering basic training was the only group of weight cyclers that exhibited a net weight loss.

Based on Army Weight Control Program standards, a large proportion of the women surveyed should lose weight. Of the 1,106 women who reported both height and weight, 486 (44%) exceeded their age and height specific screening table weight (Figure A-1). Greater proportions of enlisted women than officers exceeded their screening table weights, 46 percent versus 28 percent respectively. Of the women who exceeded their height-weight standard, 45 percent were within 10 lb of their table weight and, therefore, could relatively easily prepare for a weigh-in. But 21 percent of women who exceeded their maximum allowable weight were more than 20 lb overweight and would have to initiate a weight loss effort weeks before a weigh-in (Figure A-2).

The National Center for Health Statistics has defined obesity in terms of BMI as 27.3 for women. This value corresponds to a fat content of 32 ± 2 percent for women. Using a BMI of 27.3 as an indicator of obesity, instead of the screening table weight, only 9.3 percent of the women surveyed would be categorized as overweight. Although the emphasis is often on overweight individuals, there may be a significant number of underweight women who should not be overlooked. A Panel on Energy, Obesity, and Body Weight Standards deemed a BMI less than 20 undesirable. By this criterion, 12.4 percent of the Army women surveyed could potentially be classified as undernourished.

In summary, results of these questionnaires confirm that Army women, like their civilian counterparts, are not satisfied with their body weight or body image. Most Army women surveyed wanted to lose weight and slightly more than half were trying to do something about it. Weight cycling seems common. The findings that desirable body weights were well below the maximum allowable weights of the Army Weight Control Program indicates that most women do not consider the screening table weights overly strict. Body weight goals seem to be driven more by societal pressures than by the weight control program, although actual weight loss attempts may be strongly influenced by the semi-annual weigh-ins.

At any point in time, up to 44 percent of Army women exceed their age and height specific screening table weight, although very few of these women end up on the Army Weight Control Program. Whereas the Army Weight Control Program may be encouraging weight loss efforts, it is not promoting long-term weight maintenance and may, in fact, be encouraging unsound weigh loss methods. In the mail survey of M. S. Rose and colleagues, the major reason

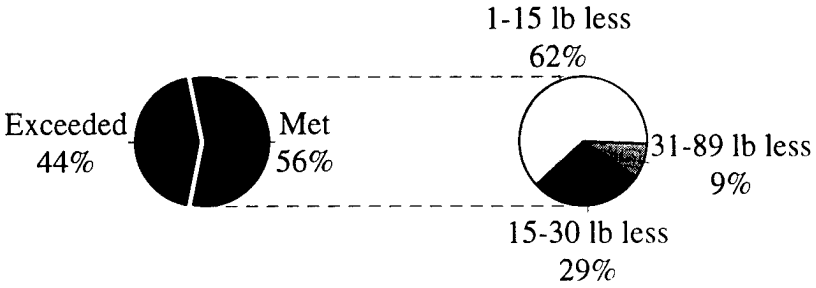


FIGURE A-1 Current weight versus screening table weight (n = 1,106).

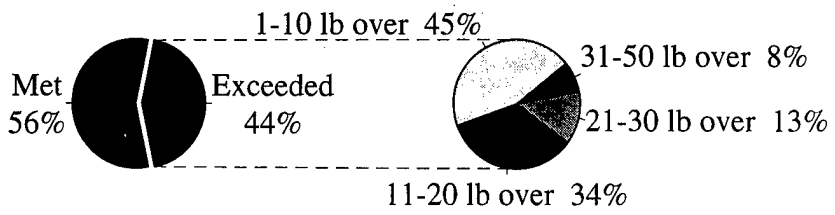


FIGURE A-2 Current weight versus screening table weight (n = 1,106).

cited for using undesirable weight loss practices (such as use of diuretics, laxatives, purging, or saunas) was upcoming weigh-in. Since so few overweight women (and probably men) are actually placed on the weight control program, dietary counseling and nutrition education should be readily available to all soldiers without risk of stigma.

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GENDER DIFFERENCES IN FOOD RATION PREFERENCES AND CONSUMPTION AMONG MILITARY PERSONNEL

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Operational rations have been developed to satisfy the food preferences of male troops. They have been modified based on feedback from male personnel in focus groups and extensive field tests where detailed measures of nutrient intake, fluid balance, body weight, food acceptance, and troop perceptions of ration attributes are used both to evaluate the adequacy of the ration and to make improvements in future versions. This approach to ration development and design was fully justified when women comprised a small fraction of servicemembers and were rarely on the front lines where troops frequently subsist on operational rations as their sole source of food. This situation has changed dramatically as women have come to represent a larger fraction of servicemembers with over 203,000 in active-duty status as of 1993. The question, of course, arises as to whether current military rations satisfy the food preferences of female servicemembers and whether the rations are consumed in adequate quantity to meet women's nutritional needs.

The data that are available to address this issue are extremely limited. Food preference surveys conducted in the military during the past three decades have included female participants. These surveys reveal substantial gender differences in food preferences that are largely consistent with data from college populations. The detailed findings from these surveys as well as some of their limitations will be reviewed in this presentation.

Information on nutrient intake in female troops subsisting on operational rations is much more limited. Studies conducted in the 1980s and in the early 1990s included a very small number of female participants, and the limited data indicated a number of nutrients were not consumed in sufficient quantity to meet the MRDA. During 1995, a substantial number of women participated in a field study that was concerned with the effects of high environmental temperature and ration macronutrient composition on food and fluid intake. The data from this study and their limitations also will be reviewed in this presentation.

HEALTH CONSEQUENCES AND ASSESSMENT OF DISORDERED EATING AND WEIGHT CONTROL BEHAVIORS

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It is well recognized that there are significant health consequences to eating disorders and disordered eating. Research has documented complications associated with starvation, self-induced vomiting, and purgative abuse leading to electrolyte disturbances, general fatigue, muscle weakness, cramping, edema, constipation, cardiac arrhythmias, paresthesia, kidney disturbances, swollen salivary glands, dental deterioration, finger clubbing, edema, dehydration, bone demineralization, cerebral atrophy, and other physical symptoms (see Table A-7). Anorexia nervosa has the highest mortality rate of any psychiatric disorder. The mechanisms of action for the major complications will be briefly reviewed.

It is well recognized that there is a connection between restrictive dieting and eating disorders. The most important factor predicting restrictive dieting is weight and shape dissatisfaction. Various approaches to gathering information on disordered eating have been suggested, including standard clinical interviews, semistructured interviews, behavioral observation, standardized self-report measures, symptom checklists, clinical rating scales, self-monitoring procedures, and standardized test meals. These methods have different aims, strengths, and weaknesses. There are special problems associated with screening for psychopathology in samples such as military women, where identification could lead to censure. Overcoming these obstacles is a key to accurate identification and intervention with those suspected of disordered eating or eating disorders. Methods for gathering information must minimize defensiveness, denial, and falsification of responses. On POWR'95, two items from the *Eating Disorders Inventory* proved to be good screening items. However, there is a need for additional screening questions to improve "hit rate." It was concluded that it is desirable to use existing measures such as the *Eating Disorders Inventory* or EAT since these instruments have demonstrated reliability and validity.

TABLE A-7 Physical Features that may Indicate an Eating Disorder

Weight loss or maintenance of a weight too low for optimal physical performance
Precipitous weight loss
Extreme fluctuations in weight
Bloating or edema
Swollen salivary glands (puffy cheeks or jaw just in front of the ear)
Amenorrhea (loss of menstrual periods)
Yellowish appearance on palms of hands or soles of feet (carotinemia)
Sores or callous on knuckles or back of hand from inducting vomiting
Hypoglycemia
Cardiac arrhythmias, bradycardia
Muscle cramps
Gastrointestinal complaints
Headaches, dizziness, weakness due to electrolyte disturbances
Numbness and tingling in limbs due to electrolyte disturbances
Renal dysfunction due to electrolyte disturbances
Proclivity to stress fractures
Loss or thinning of the hair
Downy hair appearing on the face, back, or extremities (lanugo hair)

Army Regulation 600-9 (1986) has stipulated the basis for assessing body composition to be (1) appearance, (2) performance, and (3) health. Concerns were reviewed related to the fact that Army Regulation 600-9 may lead to weight loss recommendations that are inconsistent with what is known about the feasibility of permanent weight loss and that also may inadvertently precipitate eating disorders. Moreover, this regulation may overlook the fact that high levels of military readiness may be achieved by military personnel who do not meet the present standards for body composition. They display acceptable or even superior performance and health but only fail on the grounds of appearance, and this may mean that a physical attribute, body weight, rather than performance, is forming the primary basis for enforcement. This may create a conflict between appearance goals and military readiness. The technological debate related to body composition must relate to the original basis for regulations. If health is the issue, then the magnitude of the health risk and the relative risk must be considered in relation to other known health risk factors (e.g., smoking) to determine if recommendations are consistent and proportional to relative risk. If appearance is the issue, and if the physical attribute is largely genetically determined (0.77–0.84), and if we do not have an effective treatment to reverse the condition, then are the recommendations out of step with other policies toward other historically stigmatized groups?

In contrast to the prevailing call for more aggressive dietary approaches to obesity, this presentation argued that an integration of the current scientific data and clinical experience supports the view that health professionals should, under most circumstances, not be advising patients to pursue restrictive dietary or behavioral treatments to try to achieve permanent weight loss. In part, this is based on the observation that, regardless of the specific techniques used, the vast majority of obese patients regain weight lost in treatment. No longer can we reasonably expect improved results with greater sophistication of techniques as was the case during the early period of development and refinement of behavioral technology. If inefficacy were not reason enough to abandon dietary treatments, additional arguments are receiving increasing support. The most common justification for treating obesity is its apparent adverse effects on health and longevity. These effects are, in fact, the subject of considerable controversy, and there is much evidence to suggest that maintenance of high but stable weight is safer than weight fluctuation, perhaps safer even than weight reduction. Moreover, dieting can lead to binge eating in individuals who have not experienced the symptom prior to attempting weight loss (Table A-8); it may also have other untoward psychological effects and can even precipitate serious eating disorders such as anorexia nervosa and bulimia nervosa. Instead, the focus of interventions should be on physical activity for health.

TABLE A-8 Psychological and Behavioral Symptoms That May Indicate an Eating Disorder

Excessive dieting
Excessive eating without weight gain
Excessive exercise that is not part of the training program
Guilt about eating
Claiming to feel fat when normal weight despite reassurances from others
Preoccupation with food
Avoidance of eating in public, denial of hunger
Hoarding of food
Frequent weighing
Evidence of binge eating
Evidence of self-induced vomiting
Use of drugs to attempt to control weight (abuse of laxatives, diet pills, diuretics, emetics)

CALCIUM NEEDS OF PREMENOPAUSAL WOMEN

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Calcium plays an important role in the body as a major structural constituent of bone. Low bone mineral density is an important determinant of bone fracture risk in the elderly. At any point in time, absolute bone mass is the sum of the cumulative rates of bone formation and bone loss. The accrual of bone mass occurs mainly during the period of life during which linear growth is occurring in children. A small increase in bone mass continues to occur, however, during the third decade. Factors affecting bone mineral metabolism during this period of life may determine whether one's genetic potential for peak bone mass accrual is reached. It is believed that the risk of osteoporotic fracture is dependent on the level of peak bone mass.

Genetics play the major role in determining bone mass, accounting for as much as 80 percent of the variation in this measurement. Recently, polymorphisms of the vitamin D receptor gene have been shown to be an important marker of bone mineral in women. The influence of this individual genetic marker on bone mineral density is apparently modulated by dietary calcium intake.

Pregnancy and lactation are associated with increased calcium needs to offset the calcium loss attributed to the developing fetus and for milk production. Pregnancy has little or no effect on bone mineral density in the mother. Moreover, bone loss occurs during lactation, despite quite high calcium intakes. However, this lactation-associated bone loss is apparently recovered during the year following the lactation period. The rate of lactational bone loss and the degree of bone mass recovery postlactation may be modulated by the level of dietary calcium intake. Teenage women must meet both the additional calcium needs associated with growth of the skeleton and the calcium demands of pregnancy and lactation; therefore, they represent a high risk group.

In general, low dietary calcium intake has been demonstrated to be associated with low bone mineral density. However, other environmental factors, besides dietary calcium intake, also modulate bone mineral density. One of the most consistent factors that has been shown to be associated with bone mineral density is the level of physical activity. However, extreme levels of exercise sufficient to induce amenorrhea will have a negative effect on bone. Optimal calcium intakes for preserving bone mineral probably exceed the current Recommended Dietary Allowance of 800 mg/d for adult women. A recent NIH Consensus Conference on Optimal Calcium Intakes recommends that estrogen-sufficient premenopausal women should consume 1,200 mg Ca/d.

THE FEMALE ATHLETE TRIAD: EFFECTS ON THE SKELETON

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The female athlete triad, the triad of amenorrhea, osteopenia, and eating disorders, has been the source of much publicity in the athlete. The basis of comorbidity of these variables was made in the setting of studies on exercise-induced amenorrhea. The mechanism by which caloric restriction and abnormal eating may compromise bone mass is unclear.

Exercise, particularly of a strenuous nature, can have a profound effect on reproductive function. This problem has been documented in women who participate in a variety of sports, including running, swimming, and ballet dancing. The clinical manifestations include delayed menarche, secondary amenorrhea, and irregular menses with prolonged cycles or shortened cycles because of inadequate luteal phases. The incidence of this problem varies widely among numerous reports but appears to be more common in athletic groups in which dieting to remain thin is necessary, particularly if thinness presents an athletic or artistic advantage. Reproduction dysfunction may range from minor changes in reproductive hormone production to long-term cessation of menstrual cycles and prolonged hypoestrogenism. Thus, recent work has shown that the amenorrhea, particularly with endurance training, is associated with a high incidence of eating disorders. This varies with the athletic discipline but is a definite underlying theme.

Intervals of hypoestrogenism associated with abnormal eating patterns may lead to premature bone loss or lack of bone accretion. Athletes with low bone density are susceptible to stress fractures due to overuse of bone weakened by osteopenia. A high incidence of scoliosis (23%) and stress fractures (46%) in a group of female ballet dancers has been reported. Scoliosis was most prevalent in the dancers with delayed menarche and rose significantly with increasing menarcheal age ($p < 0.05$) as did stress fractures ($p < 0.01$). The prevalence of stress fractures among dancers and runners with menstrual irregularities were found not only to have higher incidence of stress fractures (45% compared with 29% in regular runners) but also to have more multiple fractures.

Deficiency in the exercise-induced increase in bone mass in stressed bones of amenorrheic ballet dancers has also been identified. The lack of bone strengthening that usually occurs in this setting appears to lead to an increase in fracture rate, particularly in women with delayed menarche. The bone most stressed by activity (metatarsal) is the most severely deficient. Normal dancers studied had a higher metatarsal density than other groups, while the amenorrheic dancers had the lowest. The spine shows similar trends, although the strengthening process was not as marked as in the foot.

Aberrant nutrition and nutritional patterns may affect the skeleton even before changes in bone density are noted; dancers with recent stress fractures had a higher prevalence of both nutritional aberrations and weight fluctuations when compared with dancers without fractures, although differences in bone density were not noted. Treatment with estrogen replacement therapy is commonly suggested to maintain bone mass and encourage further accretion in young athletes. In a group of 26 amenorrheics, randomized into treatment with estrogen-progestin

replacement therapy (Premarin 0.625 mg, Provera 10 mg for 10 days) or placebo for 2 years, no differences were noted in treated vs. untreated groups. Thus, other factors besides hypoestrogenism appear to affect the (lowered) bone mass seen in young women and replacement doses of estrogen-progestin do not appear to change bone mineral density significantly over a 2-y period. The exercise-induced osteopenia is most likely affected by nutritional factors, which, in turn, probably have an effect on bone by multiple mechanisms.

THE IMPACT OF PHYSICAL FITNESS AND GENDER-INTEGRATED TRAINING ON RISKS OF STRESS FRACTURES AND OTHER INJURIES AMONG WOMEN IN ARMY BASIC TRAINING

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Historically, the incidence of injuries among women during Army BCT has been twice as high as for men (Bensel and Kish, 1983; Jones, 1983; Jones et al., 1993a; Kowal, 1980). The reported incidence of stress fractures among women has been even higher, 2 to 10 times higher than for men. Knowledge of the higher rates of injury among women in BCT caused concern that the incidence of injury might be even higher when training for men and women was integrated into the same units in 1994. To determine the impact of integrated training on the incidence of injury among women, a study was conducted at Fort Leonard Wood, Missouri, in November and December 1995. Because it has been well established that lower levels of physical fitness are associated with higher risks of injury for both men and women (Jones et al., 1993a, b), physical fitness also was examined during this study.

The population for the study included men (N = 470) and women (N = 284) in 6 BCT companies in the sixth, seventh, or eighth week of training. The medical records of every trainee on the unit training rosters were screened for illnesses and injuries. An injury was defined as a musculoskeletal complaint requiring medical attention. Scores on the initial entry physical training test also were obtained for each participant. Overall, Fort Leonard Wood recruits had slower average run times, higher average weights, and higher average BMIs as compared to recruits in a similar study conducted at Fort Jackson in 1988 (see Table A-9). As with earlier studies, women entering BCT at Fort Leonard Wood exhibited lower levels of physical fitness than men. Analysis of data from two companies in their seventh week of training showed that the incidence of injury among women was found to be 1.6 times higher than for men (57% vs. 36%, p= 0.001). The stress fracture incidence was 2.5 times higher among women (9% vs. 3.6%, p = 0.06). These incidences of injury were somewhat higher than past rates for both men and women (see Table A-10) and may correspond to the lower physical fitness levels seen among the Fort Leonard Wood recruits.

Similar to past reports (Bell and Jones, 1993; Jones et al., 1992; Jones et al., 1993a), men and women exhibiting lower levels of physical fitness as measured by run time experienced higher rates of injury than their more fit peers. Male recruits with slower run times had

TABLE A-9 Physical Fitness of Men and Women Starting Army Basic Combat Training: A Comparison of 1995 and 1988 Data

Measurements	Ft. LW, 1995 Men Mean (SD)	Ft. Jackson, 1988 Men Mean (SD)	Ft. LW, 1995 Women Mean (SD)	Ft. Jackson, 1988 Women Mean (SD)
2-mi run time	17.3 (2.4)	16.4 (2.2)	22.5 (2.7)	20.3 (2.3)
Height	175.5 (8.5)	175.2 (7.1)	161.5 (7.3)	162.0 (6.5)
Weight	77.2 (12.3)	75.7 (12.2)	62.1 (7.6)	58.3 (6.5)
BMI (wt/ht^2)	25.1 (2.4)	24.6 (3.6)	23.0 (2.4)	22.2 (2.0)

SOURCE: Adapted from Canham et al. (1996) and Jones (1996).

significantly higher incidences of both overall injury (see Table A-11) and stress fractures (see Table A-12). Female recruits with slower run times had significantly higher incidence of stress fractures (see Table A-13) but did not exhibit significantly higher incidence of overall injury as compared to their faster peers (risk ratio, slow vs. fast = 1.3, p = 0.8). Also, as with several past studies (Bell and Jones, 1993; Jones et al., 1992), the incidence of injury was found to be similar for men and women of the same aerobic fitness level (i.e., when fitness was controlled for by stratified analysis the incidence of injury was similar for both genders, risk ratio, women vs. men = 1.2, $p = 0.64$). We concluded that integrated training did not increase the risk of injury among women in this population and that low levels of physical fitness were an important risk factor for men and women.

TABLE A-10 Incidence of Women and Men Injured During Basic Training Reported in Previous Studies from 1980 to 1995

Author	Post	Year	Weeks in Training	Women (%)	Men (%)	Relative Risk*
—	Ft. LW	1995	7	57	36	1.6
Reynolds	Ft. Jackson	1993	8	67	—	—
Bell	Ft. Jackson	1988	8	62	29	2.1
Jones	Ft. Jackson	1984	7	50	28	1.8
Bensel	Ft. Jackson	1983	8	42	23	1.8
Kowal	Ft. Jackson	1980	8	54	26	2.1

* Relative risk, incidence in women/incidence in men.

SOURCE: Adapted from Canham et al. (1996) and Jones (1996).

TABLE A-11 Two-Mile Run Time and Incidence (%) of Injury Among Male Trainees at Fort Leonard Wood,* 1995

Quartile of run time (minutes)	n	Risk (%) of injury
Q1 (1–15.72)	39	26
Q2 (15.73–17.33)	40	25
Q3 (17.34–19.05)	38	40
Q4 (19.06+)	38	50

NOTE: Risk ratio (slow vs. fast) = 1.8, $p = 0.01$, 95% CI = 1.1, 2.8; Chi-square for trend = 6.5, $p = 0.01$.

* Companies in their seventh week of training

SOURCE: Adapted from Canham et al. (1996) and Jones (1996).

TABLE A-12 Two-Mile Run Time and Incidence (%) of Stress Fractures* Among Male Trainees at Fort Leonard Wood†, 1995

Run time half (minutes)	n	Risk (%) of stress fracture
H1 (1–17.33)	79	1
H2 (17.34+)	76	10

NOTE: Risk ratio (slow vs. fast) = 7.3, $p = 0.03$, 95% CI = 0.9, 57.7.

* Includes stress reactions and stress fractures.
† Companies in their seventh week of training.

SOURCE: Adapted from Canham et al. (1996) and Jones (1996).

TABLE A-13 Two-Mile Run and Incidence (%) of Stress Fractures* Among Female Trainees at Fort Leonard Wood†, 1995

Run time half (minutes)	n	Risk (%) of stress fracture
H1 (1–22.67)	48	10
H2 (22.68 +)	47	26

NOTE: Risk ratio (slow vs. fast) = 2.5, $p = 0.06$, 95% CI = 0.9, 6.4.

* Includes stress reactions and stress fractures.
† Companies in their seventh week of training.

SOURCE: Adapted from Canham et al. (1996) and Jones (1996).

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CLINICAL IMPACT OF U.S. ARMY POLICIES AND PROCEDURES ON PREGNANCY, THE POSTPARTUM PERIOD, AND BODY COMPOSITION: TWENTY YEARS OF EXPERIENCE

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Pregnant soldiers are issued an activity profile that is designed to "...protect the fetus while ensuring the productive utilization of the servicewoman." That goal seems to be achieved, although some studies have suggested that active-duty status is an independent risk factor for pregnancy (e.g., Magann and Nolan, 1991). Pregnancy outcomes are not improved over the general population in spite of defined limitation of work and ready access to health care. Pregnant soldiers are excused from the Army Body Composition Program standards and from physical fitness testing for the duration of the pregnancy. Postpartum soldiers are excused from those requirements for 6 months after delivery.

Pregnant soldiers are detrimental to unit readiness through nondeployability, activity limitations, lost duty time, and unit morale effects. There was an explosion of promiscuity among female soldiers in Europe beginning late 1991 when VIIth Corps deployment to the Gulf was announced, since pregnancy meant nondeployability. As an indicator, sexually-transmitted-disease rates in female American soldiers in Würzburg, Germany during that time increased several hundred percent. Female soldiers constituted only 6 percent of the Americans in the Gulf but accounted for 18 percent of the sick-call workload. Sixty percent of field hospital admissions

in the Gulf War were for pregnancy complications, and most evacuations of women were for pregnancy.

The Army Body Composition Program provides for body fat determination for soldiers who exceed screening weight or whose appearance suggests excessive body fat. Soldiers who exceed body fat standards have favorable personnel actions suspended: nonpromotable, no command, no professional military schooling. The Army expends literally hundreds of thousands of manhours annually on the Army Body Composition Program. In my personal conversations during my career with more than 50 current and former commanders, ranging in rank from 2LT to MG, not one of those officers thinks that the Army Body Composition Program helps them field better warfighters. Changing demographics of the U.S. population suggest that current Army Body Composition Program standards may not fit the solders of Army 21 well. The correlation between body fat and fitness is weak; the absence of policies which censure soldiers for tobacco use or excessive alcohol use undermines the assertion that the Army Body Composition Program is health-motivated rather than purely cosmetic.

The Army Body Composition Program should be discontinued, and the manhours currently consumed by the Army Body Composition Program should be diverted to battle drills and other activities which will enhance readiness. Research concerning body composition, nutrition, and physical training should focus on identifying valid *performance* criteria for selecting and training soldiers.

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THE IMPACT OF PREGNANCY WEIGHT RESTRICTION, POSTPARTUM EXERCISE, AND WEIGHT LOSS ON LACTATION

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Pregnancy Weight Restriction and Lactation Performance

Observational studies performed in industrialized countries have not shown a *direct* association between pregnancy weight gain and lactational performance. However, since mothers who gain more weight tend to have higher birthweight infants and higher fat stores than mothers who gain less weight, there may be an *indirect* association of pregnancy weight gain with lactational performance by the following two mechanisms. First, there is a positive relationship between infant milk intake and birthweight, due to the fact that larger infants demand more milk than smaller infants. Second, milk fat concentration is positively associated with maternal fatness. On the other hand, the impact of maternal fatness on milk energy output is modified by infant self regulation, such that infants of mothers with high milk fat will demand a lower milk volume. The model put forth by Perez-Escamilla et al. (1995) illustrates the relationships among maternal fatness, birthweight, and the role of the infant in determining infant milk energy intake

(Figure A-3). This model is consistent with the physiological regulation of lactation, which operates through endocrine and autocrine mechanisms governed by infant demand. Thus, within the range of weight gain normally observed during pregnancy, there is no evidence that pregnancy weight gain restriction will affect lactation performance.

Lactation and Weight Loss

The question of whether exercise poses any harm to maternal milk supply was first studied by Lovelady et al. (1990). There were no significant differences in lactation outcomes between lactating women who exercised aerobically for an average of 88 min/d and those who did not exercise. Because subjects in that study were self-selected, the same research group next undertook a randomized intervention trial (Dewey et al., 1994). Thirty-three exclusively breastfeeding women were assigned to either an aerobic exercise group (45 min/d, 5 d/wk) or a control group (no vigorous exercise > 1 d/wk) for 12 weeks. Although mothers in the exercise group increased their total daily energy expenditure by 400 kcal/d at the midpoint of the intervention compared to the control group ($p < 0.05$), there was little difference at the end of the intervention period because the exercising mothers cut back on other types of activities. There was no adverse impact of the exercise program on lactational performance. In addition, aerobic capacity significantly improved in the exercisers compared to controls ($p < 0.05$). However, there was no difference in weight or body fat loss in the exercising group compared to the control group because the exercise group increased their energy intake. High intensity exercise has been shown to cause a transitory increase in breast milk lactic acid concentration (Wallace et al., 1992), but this is not harmful to the infant. Although some infants may find the more acidic taste less "acceptable," this is not likely to interfere with milk intake in most cases.

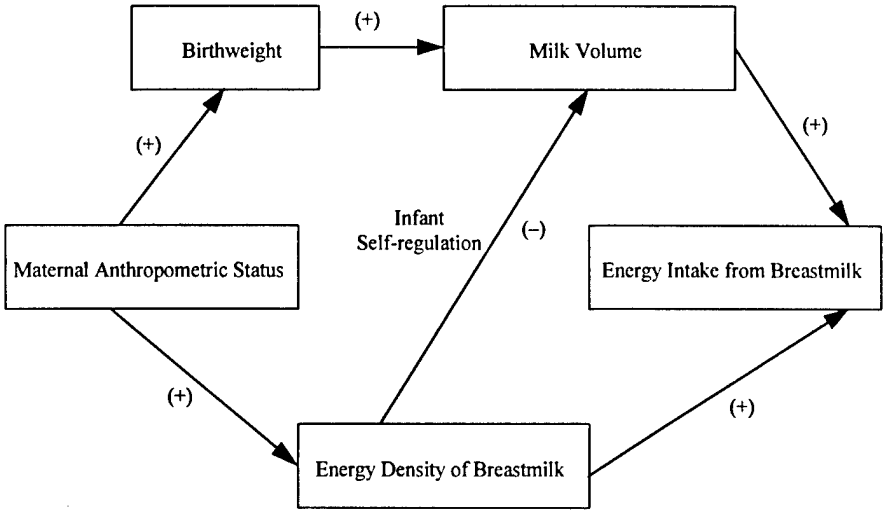


FIGURE A-3 Model illustrating the relationships among maternal fatness, birthweight, and the role of the infant in determining infant milk energy intake. SOURCE: Perez-Escamilla et al. (1995), used with permission (© *American Journal of Clinical Nutrition*, American Society for Clinical Nutrition).

A gradual weight loss of about 0.8 kg/mo is normal during lactation. In fact, breastfeeding usually promotes weight loss (see Table A-14). In the 11 studies that have examined the impact of breastfeeding on postpartum weight loss, the results are mixed. But of the seven studies in which breastfeeding was clearly defined by more than simply yes/no or any/non (e.g., duration was known), six show that breastfeeding is related to greater maternal weight loss, or less maternal weight retention (defined as current minus prepregnancy weight). Studies in which skinfold thicknesses of postpartum mothers were measured demonstrate that there is a loss of fat associated with breastfeeding. There is no evidence that moderate weight loss (up to 2 kg/mo), in overweight women, has adverse effects on lactation. However, the effects of rapid weight loss are unknown. Lactation may be more vulnerable to the effects of weight loss in the first month postpartum, but there have been no studies on this question. Currently, the Institute of Medicine advises that lactating women who want to lose weight take in no less than 1,800 kcal/d, drink plenty of water, avoid liquid diets or weight loss medications, and continue to nurse on demand. Additional studies in this area are currently underway, which should provide more specific advice concerning weight loss among breastfeeding women.

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TABLE A-14 Lactation and Postpartum Weight Loss

Reference	Location	*N*	Design	Def. BF	Outcome	Results	Comments
Öhlin and Rössner, 1990	Sweden	1,423	Prosp.	Score	Weight loss	Significant	2.5–6 months only
Potter et al., 1991	United States	411	Retro.	BF ≥ 6 weeks	Estimated weight loss	Not significant or positive	
Schauberger et al., 1992	United States	795	Prosp.	Yes/no	Weight loss	Not significant	
Adair and Popkin, 1992	Philippines	3,051	Prosp.	Duration and intensity	Weight loss	Significant	Also skinfold
Dewey et al., 1993	United States	85	Prosp. (matched cohorts)	BF ≥ 12 months	Weight loss	Significant	Also skinfold, excluded dieters
Parker and Abrams, 1993	United States	2,119	Retro.	Duration and intensity	Excess weight retention	Not significant	
Keppel and Taffel, 1993	United States	2,944	Retro.	BF ≥ 4 months	Weight retention	Significant?	
Kramer et al., 1993	United States	24	Prosp.	BF ≥ 6 months	Weight loss	Significant	Also skinfold
Boardley et al., 1995	United States	345	Retro.	Any BF	Weight retention	Not significant	Low %FBF
Scholl et al., 1995	United States	274	Prosp.	Any BF	Weight retention	Not significant	Low %BF
Janney et al., 1997	United States	110	Prosp.	Duration and intensity	Weight retention	Significant	

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PREGNANCY AMONG NAVY WOMEN

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Pregnancy is not an illness, but is a time of physiologic changes which: (1) diminish some physical skills, (2) increase vulnerability to common hazards, (3) may lead to pregnancy-specific illnesses, and (4) leave the fetus vulnerable to common environmental hazards. Policies regarding the assignment and utilization of pregnant servicewomen in the Navy are based on the known pregnancy physiologic changes, perinatal risks, and known or suspected environmental hazards. Such policies include the "20-week rule," the "6-hour rule," and the "Commanding Officer's Prerogative." Overseas assignments often are restricted. Physical training is restricted during pregnancy and for 6 months following delivery.

B

Practices and Policies Tables

Portions of the Practices and Policies Tables appear in the Executive Summary and Chapters 2, 3, and 6 of the report.

TABLE B-1 U.S. Military Practices and Policies Pertaining to Body Composition, Fitness, and Pregnancy

Practice or Policy	DoD Directive/ Instruction	Army	Navy	Air Force	Marine Corps	Coast Guard
Frequency of Weight/Height, BF, and Fitness Assessment	Formally evaluated and tested at least annually	Semiannual	Semiannual PRT optional for members > 50 years (NAVOP 064/90, 1990)	Annual	Semiannual	At least annual and upon random urinalysis testing
Assessment Procedures*	Circumference measure technique	Circumference measure if maximum allowable weight for height exceeded	Circumference measure if maximum allowable weight for height exceeded	Circumference measure if maximum allowable weight for height exceeded	Circumference measure if maximum allowable weight for height exceeded	Frame size determined by wrist measure (see COMDTINST M1020.8C, 1994) Circumference measure if maximum allowable weight for height exceeded
Men's BF Standard	Range: 18–26%	Age Max %BF 17–20 20 21–27 22 28–39 24 40+ 26 (AR 600-9, 1986)	22%	Age %BF ≤ 29 20 30+ 24	18%	Maximum allowable weight by frame size or if exceeded Age %BF < 30 23 31–39 25 40+ 27
Women's BF Standard	Range: 26–36%	Age Max %BF 17–20 30 21–27 32 28–39 34 40+: 36 (AR 600-9, 1986)	30% (NAVADMIN 071/93, 1993)	Age %BF ≤ 29 28 30+ 32	26%	Maximum allowable weight by frame size or if exceeded Age %BF < 30 33 31–39 35 40+ 37

Fitness Test	Annual Adjusted for age and gender Cardiovascular and muscular endurance (DODI 1308.3, 1995)	Adjusted for age and gender (AR 350-41, 1993) 2-mi run Sit-ups×2 min† Push-ups×2 min	Sit-reach Curl-ups×2 min Push-ups×2 min 1.5-mi run/walk or 500-yd swim (age and gender adjusted) + BF standards (OPNAVINST 6110.1D, 1990)	Submaximal cycle ergometer test, percent of standard based on $\dot{V}O_2$max, age and gender specific (AFI 40-501, 1996)	Men: 3-mi run Curl-ups Push-ups Pull-ups×2 min Women: 1.5-mi run Curl-ups Push-ups Bent-arm hang×2 min	None
Duty Time for Physical Fitness	May authorize 1½ hrs 3×/wk	Authorize duty time	Commanding officer's discretion	Commanding officer's discretion	Part of weekly training day	Commanding officer's discretion
Deferrals/Waivers		Hospitalization Prolonged treatment for medical limitations	Medical limitations Unique body builds Up to 36%	Medical limitations	?	Medical limitations Smoking cessation: after successful completion of a smoking cessation class, member given a one time 6-mo exemption to weight standards
	Pregnancy	•Exempt from body composition, fitness testing (AR 40-501, 1995) •Nondeployable •At 20 weeks, standing at parade rest/attention < 15 minutes •At 28 weeks, 40-h week/8-h day	•Exempt from body composition, fitness testing •20-wk Rule (no shipboard duty after 20th week of gestation) •6-h Rule (medical evacuation for ER must be within 6 hours) (OPNAVINST 6000.1A, 1989)	•Exempt from body composition, fitness testing •Restrictions based on work environment •Pregnant members assigned to areas without obstetrical care will have assignment curtailed by 24th week (AFI 44-102, 1996)	•Full-duty status and deployable until medical officer certifies that full duty is medically inadvisable •May not participate in contingency operations or be deployed for operations aboard Navy vessels	•Exempt from body composition testing •>28 weeks, 40-h work week; no overseas duty •Other duty restrictions based on work environment; no rescue swimmer duties •Not deployable during 20th week through 6 months postpartum

Continued

TABLE B-1 *Continued*

Practice or Policy	DoD Directive/ Instruction	Army	Navy	Air Force	Marine Corps	Coast Guard
Deferrals/Waivers *continued*	Pregnancy *continued*		•40-h work week •Standing at parade rest/attention no more than 20 minutes		•Flight personnel are grounded unless cleared by medical waiver •Excused from duties (physical training or standing in formation) that in the opinion of the medical officer are hazardous to her health or to her unborn child •Remains available for worldwide assignment •Pregnant Marines stationed in Hawaii will not be detached after their 6th month; if overseas, they may be detached at their normal rotation tour date; if assigned to shipboard duty, the Marine will be reassigned at first opportunity and no later than the 20th week of pregnancy	•Time to medical evacuation for emergencies < 3 hours •No flight duties after 2nd trimester •Prenatal sick leave not to exceed 30 days
	Postpartum	•Return to duty at 6 weeks •Exempt from weigh-in until 6	•Return to duty at 6 weeks •Exempt from weigh-in until 6	•Return to duty at 6 weeks •Exempt from weigh-in until 6	•Return to duty at 6 weeks (or as soon after delivery as medical officer	For nursing mothers, the 6-mo weight standards exemption following delivery

		months •Physical training at own pace for 45 days •Exempt from fitness testing for 135 days (FM 21–20, 1992) •Deferment from deployment until 4 months postpartum •No policy regarding breastfeeding	months •Exempt from fitness testing for 6 months •Deferment from deployment until 4 months postpartum •No policy regarding breastfeeding	months •Deferment from deployment until 4 months postpartum •Exempt from fitness testing for 6 months (AFI 40-502, 1994) •Commander may approve up to 18 months deferral •No policy regarding breastfeeding	certifies) •Exempt from weigh-in until 6 months •Exempt from fitness testing for 6 months •Deferment from deployment until 4 months postpartum •(MCO 5000.12D, 1995) •No policy regarding breastfeeding	will begin at the conclusion of the nursing period, but no later than 12 months postdelivery •Postdelivery maternity leave up to 6 weeks •Not deployable until 6 months postpartum •Exempt from weight standards for up to 6 months
Medical Evaluation Requirement	Required 3 months after entry if unsatisfactory	Same as DoD	Required before entry	Required before entry	Required before entry	Upon being found not in compliance with weight standards, members shall be referred to a medical facility
Referrals for Weight Loss	Fat Reduction Program for 3 months; then medical referral Progress = ~3–8 lb weight loss monthly or 1% reduction in BF each month		2-wk outpatient weight-management program Also mandatory physical conditioning program	Mandatory 90-d program 6-mo follow-up 1-y probationary period		Upon initial referral to medical facility after being found not in compliance with weight standards, members receive counseling on proper nutrition and exercise to reduce their excess BF

Continued

TABLE B-1 *Continued*

Practice or Policy	DoD Directive/ Instruction	Army	Navy	Air Force	Marine Corps	Coast Guard
Referrals for Eating Disorders	None	Counseling, mental health, and nutritional group/ individual in-patient/out-patient treatment	Nutrition/medical/ psychological/ counseling available Assistance program available for self-referral	Policy currently not addressed	No specific treatment program	Full-time nutrition/medical/ psychological counseling available Assistance program available for self-referral
Reasons for Discharge	Continued failure of weight loss over reasonable period of time	Pregnancy and overseas assignment–"it depends"	Any 3 BF/PRT failures in 4 years (NAVADMIN 071/93, 1993) Waiver (review) for above (NAVADMIN 148/94, 1994) Diagnosis of bulimia or anorexia nervosa	Considered if member fails to make satisfactory progress in the Weight Management Program on 4 occasions (AFI 40-502, 1994)	?	Fails to comply with the weight standards by the end of their probationary period or upon initial medical referral, an underlying medical condition is found, and the medical officer determines that any weight loss/fat loss by member would be detrimental to the member's health, separation procedures are initiated

NOTE: DoD, Department of Defense; BF, body fat; PRT, physical readiness test; $\dot{V}o_2max$, maximal oxygen consumption.

* See Table B-2 for equations.

† Number of sit-ups performed in 2 minutes.

TABLE B-2 U.S. Military Body Composition Equations

Army (Vogel et al., 1988)

Men

Percent fat = $76.5 \times \text{Log}_{10}(\text{abdomen II}^{*} - \text{neck}) - 68.7 \times \text{Log}_{10}(\text{height}) + 46.9$

$R = 0.82$, SEE = 4.02

Women

Percent fat = $105.3 \times \text{Log}_{10}(\text{weight}) - 0.200 \times \text{wrist} - 0.533 \times \text{neck} - 1.574 \times \text{forearm} + 0.173 \times \text{hip} - 0.515 \times \text{height} - 35.6$

$R = 0.82$, See = 3.60

Navy (Hodgdon and Beckett, 1984a, b) and Air Force

Men

Density = $-0.191 \times \text{Log}_{10}(\text{abdomen II} - \text{neck}) + 0.155 \times \text{Log}_{10}(\text{height}) + 1.032$

Percent fat = $100 \times [(4.95/\text{density}) - 4.5]$

$R = 0.90$, SEE = 3.52

Women

Density = $-0.350 \times \text{Log}_{10}(\text{abdomen I}^{\dagger} + \text{hip} + \text{neck}) + 0.221 \times \text{Log}_{10}(\text{height}) + 1.296$

Percent fat = $100 \times [(4.95/\text{density}) - 4.5]$

$R = 0.85$, SEE = 3.72

Marine Corps (Wright et al., 1980, 1981)

Men

Percent fat = $0.740 \times \text{abdomen II} - 1.249 \times \text{neck} + 40.985$

$R = 0.81$, SEE = 3.67

Women

Percent fat = $1.051 \times \text{biceps} - 1.522 \times \text{forearm} - 0.879 \times \text{neck} + 0.326 \times \text{abdomen II} + 0.597 \times \text{thigh} + 0.707$

$R = 0.73$, SEE = 4.11

NOTE: Circumference measurements and height are in centimeters. SEE, standard error of the estimate.

* Abdomen II is the circumference, measured in transverse plane, at the level of the umbilicus.

† Abdomen I is the "natural waist" and is defined as the smallest circumference, measured in the transverse plane, obtained between the lower margin of the xiphoid process and the umbilicus.

SOURCE: Adapted from Hodgdon (1992).

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C

Military Occupational Specialty Classification Tables

A summary table of the Military Occupational Specialty Classification Tables appears in Chapter 3.

TABLE C-1 Military Occupational Specialty Classification Table: Enlisted Job Classifications with Very Heavy Strength Requirements for Women in the Services as of September 1996

	Service Branch—OCC Classification Number		
DoD OCC Classification Number	Army	Navy	Air Force
012 Military Training Instructor			1T0X0, 1T0X1
030 Bridge Crew Member	12C		
041 Artillery and Gunnery		GM	
062 Small Boat Operators	88K		
102 Navigation, Communications	68J, 68N		
113 Shipboard and Other Fire Control	45G		
121 Missile Guidance and Control	27E, G, M, T		
198 Electronic Instrument.	35Y		
201 Radio Code	31C		
222 Air Traffic Control	93C		
231 Intercept Operators	97G, 98G, 98H		
412 Surveying	82C		
431 Explosive Ordinance Disposal (Ordinance Display and Diving)	55D		
433 Divers	00B		
494 Nuclear, Biological and Chemical Warfare Specialists	54B		
495 Fire Fighter	51M		3E7X1, 3E7X0
531 Data Processing - Operators/Analysts	74B		
551 Supply Administration	92A		

Continued

TABLE C-1 *Continued*

	Service Branch—OCC Classification Number		
DoD OCC Classification Number	Army	Navy	Air Force
554 Transportation			8P000
556 Aviation Operations Specialist	93P		
600 Aircraft, General	67N, S, T, U, Y		2A5X2
601 Aircraft Engines	68B	AE	
602 Aircraft Accessories	68D, 68F	ABE, ABF, ABH	2A6X3
610 Automotive, General	63B, G, S, W		
611 Tracked Vehicles	63 H, Y		
612 Construction Equipment		CM	
621 Lineman			2E6X0, 2E6X1
622 Central Office	35N		
632 Missile Mechanics			2M0X2
641 Small Arms Repair	45B		
643 Turret Repair	45K		
645 Ammunition Repair	55B		
646 Aviation Ordinance	68X	AO	
651 Main Propulsion		MM	
652 Auxiliaries	88L	EN	
662 Electric Power	52D, F	EM	
690 Other Mechanical and Electrical Equipment, General	63J		
704 Metal Body Repair	44B		
710 Construction, General		BU	3E0X0, 3E2X1
711 Steelworking		SW	

Continued

TABLE C-1 *Continued*

DoD OCC Classification Number	Service Branch—OCC Classification Number		
	Army	Navy	Air Force
712 Woodworking	51B		
713 Construction Equipment Operation	62E, F, G, H, J		
720 Utilities, General	51K, 77W	UT	3E1X1
721 Electricians		CE	3E0X1, 3E0X0
760 Fabric, Leather and Rubber, General	43M		
790 Other Crafts Workers, Navy Enlisted Classification, General		DC, ML	
811 Motor Vehicle Operations	88M		
821 Missile Fuel and Petroleum	77F		
822 Warehousing and Equipment Handling	88H		
840 Laundry and Personal Service, General	57E		
860 Forward Area Equipment Support, General	92R		
Percent OCC classifications in this strength category	41.4%	23.9%	5.7%
Total number of women in this strength category	17,617	3,889	226
Percent women in this strength category	32.7%	11.3%	< 1.0%

NOTE ON TABLE C-1: Army defines very heavy strength requirement as ability to lift on occasional basis over 100 lb (45 kg) with frequent or constant lifting in excess of 50 lb (23 kg). Corresponds to Navy's high/high and Air Force's high strength requirements.

TABLE C-2 Military Occupational Specialty Classification Table: Enlisted Job Classifications with Heavy Strength Requirements for Women in the Services as of September 1996

	Service Branch—OCC Classification Number		
DoD OCC Classification Number	Army	Navy	Air Force
101 Radio and Communications Security	35E		
102 Navigation, Communication	31R		
104 Surveillance/Target Acquisition	35C		
121 Missile Guidance and Control	35B		
123 Torpedo Repair		TM	
160 Teletype and Cryptographic Equipment, General	35J	WT	
198 Electronic Instruments	35F, 39B		
300 Respiratory Specialist	91V		
301 Surgery	91D		
413 Drafting	51T		
420 Weather, General	93F		
491 Physical Science Laboratory	77L		
492 Memorial Activities and Embalming	92M		
531 Operators, Analysts	74G		
551 Supply Administration	92Y	SK	
600 Aircraft General	67V		
601 Aircraft Engines		AD	
602 Aircraft Accessories	68H	AS	
603 Aircraft Structures	68G	AME, AMH, AMS	

Continued

TABLE C-2 *Continued*

DoD OCC Classification Number	Service Branch—OCC Classification Number		
	Army	Navy	Air Force
612 Construction Equipment	62B		
621 Lineman	31L		
647 Mines and Degaussing		MN	
652 Auxiliaries		GSM	
702 Machinists	44E	MR	
721 Electricians	51R		
740 Lithography, General		LI	
790 Other Craftsworkers, Navy Enlisted Classification, General		HT	
800 Food Service, General	92G	MS	
823 Sales Store		SH	
Percent OCC classifications in this strength category	14.8%	20.9%	NA
Total number of women in this strength category	9,269	6,157	NA
Percent women in this strength category	17.2%	17.8%	NA

NOTE ON TABLE C-2: Army defines heavy strength requirement as ability to lift on occasional basis a maximum of 100 lb (45 kg) with frequent or constant lifting of 50 lb (23 kg). Corresponds to Navy's high/moderate strength requirements.

TABLE C-3 Military Occupational Specialty Classification Table: Enlisted Job Classifications with Moderate Heavy Strength Requirements for Women in the Services as of September 1996

	Service Branch—OCC Classification Number		
DoD OCC Classification Number	Army	Navy	Air Force
043 Rocket Artillery	16T		
050 Air Crew, General		PR	1A0X0, 1A0X1, 1A1X0, 1A1X1, 1A2X0, 1A2X1
070 Security Guard			3P0X1
101 Communications, Radio	31P, U		3P0X0
102 Navigation, Communications	31S, 33R		
104 Surveillance/Target Acquisition and Tracking Radar	35M		
121 Missile Guidance and Control	27H	FC, GSE	
198 Electronic Instruments	35H		
232 Signals Intelligence Analyst	98C		
233 Electronics Countermeasure	96H, 98J		
250 Combat Operations Control, General			1C4X1
260 Communications Center, Operations, General	31F, 74C		
300 Medicare Care and Treatment, General	91B, 91C	HM	
311 Biomedical Laboratory Services	91K		
312 Pharmacy	91Q		
313 Radiology	91P		

Continued

TABLE C-3 *Continued*

	Service Branch—OCC Classification Number		
DoD OCC Classification Number	Army	Navy	Air Force
321 Veterinary Medicine	91R, T		
325 Diet Therapy	91M		
326 Biomedical Equipment Maintenance and Repair	91A		
330 Dental Care, General	91E		
331 Dental Laboratory	91EN5		
400 Photography, General	25R, 25V		
412 Surveying	82D		
491 Physical Science Laboratory			95200
531 Data Processing Operations/Analyst			95100
553 Transportation	88N		
554 Postal			8M000
561 Chaplain's Assistant	71M	RP	
600 Aircraft, General	67R		2A3X3, 2A5X0, 2A5X1, 2A3X0, 2A3X1, 2A3X2
602 Aircraft Accessories			2A6X5, 2A6X6
621 Telephone Systems			2E6X3
623 Interior Communications		IC	
646 Aviation Ordinance			2W1X1
662 Electric Power	52C		3E0X2
710 Construction, General			3E3X1

Continued

TABLE C-3 *Continued*

DoD OCC Classification Number	Service Branch—OCC Classification Number		
	Army	Navy	Air Force
821 Missile Fuel and Petroleum			2F0X0, 2F0X1
830 Law Enforcement, General	95B		3P0X2
831 Corrections	95C		8J000
860 Forward Area Equipment Support			1T1X1, 1T1X0
Percent OCC classifications in this strength category	22.2%	9.0%	11.4%
Total number of women in this strength category	15,535	7,207	4,404
Percent women in this strength category	28.9%	20.9%	8.6%

NOTE ON TABLE C-3: Army defines moderate heavy strength requirement as ability to lift on occasional basis a maximum of 80 lb (36 kg) with frequent or constant lifting of 40 lb (18 kg). Corresponds to Navy moderate/moderate strength requirements.

TABLE C-4 Military Occupational Specialty Classification Table: Enlisted Job Classifications with Medium Strength Requirements for Women in the Services as of September 1996

	Service Branch—OCC Classification Number		
DoD OCC Classification Number	Army	Navy	Air Force
101 Communications, Radio			2E0X0, 2E1X0, 2E1X1, 2E1X3, 2E0X1
102 Navigation, Communications	33T, Y	AT, CTM	2A4X0, 2A4X1, 2A4X2, 2A4X3, 2A1X3, 2A1X2
104 Surveillance, Target Acquisition	27K		
150 Automated Data Processing Computers, General			2E2X1
160 Teletype and Cryptographic Equipment, General			2E3X1
191 Training Devices			2E1X4
198 Electronic Instruments			2A5X3, 2E5X1, 2P0X0, 2P0X1
201 Radio Code			3C1X1, 3C2X1
241 Language Interrogation/Interpretation	97L		
242 Image Interpretation	96D		
243 Operational Intelligence	37F, 96B, 96U		
244 Counterintelligence	97B		
250 Combat Operations Control, General	93B (Aeroscout obs)		
300 Medical Care and Treatment, General			4N0X0, 4N0X1
305 Aerospace and Undersea Medicine			4F0X0, 4F0X1

Continued

TABLE C-4 *Continued*

DoD OCC Classification Number	Service Branch—OCC Classification Number		
	Army	Navy	Air Force
312 Pharmacy			4P0X0, 4P0X1
313 Radiology			4R0X0, 4R0X1
322 Environmental Health Services	91S		4B0X0, 4E0X0, 4B0X1, 4E0X1
323 Ophthalmology, Optometry	42E		
340 Medical Administration.	71G		
341 Medical Logistics	76J		4A1X0, 4A1X1
400 Photography, General	25M		3V0X3, 3N0X2, 3V0X2
411 Mapping	81Q		
420 Weather, General			1W0X0, 1W0X1
431 Explosive Ordinance Disposal			3E8X0, 3E8X1
450 Musicians, General	02-C, E, F, H, K, L, M, N, T, U	MU (94)	
494 Nuclear, Biological, and Chemical Warfare Specialists			3E9X0, 3E9X1
500 Personnel, General	75B, F		
510 Administration General	71L		
551 Supply Administration		AK	
553 Transportation			2T0X0, 2T0X1, 2T2X0, 2T2X1
556 Flight Operations	93P		
558 Functional Analysis			2R1X0, 2R1X1

Continued

TABLE C-4 *Continued*

DoD OCC Classification Number	Service Branch—OCC Classification Number		
	Army	Navy	Air Force
601 Aircraft Engines			2A6X1
602 Aircraft Accessories			2A6X4
603 Aircraft Structures			2A7X3
610 Automotive General			2T3X0, 2T4X1, 2T4X0
612 Construction Equipment			2T3X1, 2T3X0, 2T3X2
632 Missile Mechanic	24T		
645 Ammunition Repair			2W0X1, 2W0X0
700 Metalworking General			2A6X0, 2A6X2
704 Metal Body Repair			2T4X2, 2T4X0, 2T4X1
720 Utilities, General			3E4X1, 3E4X3, 3E4X0
760 Fabric, Leather, and Rubber, General			2A7X4
800 Food Service, General			3M0X0, 3M0X1
811 Motor Vehicle Operators			2T1X0, 2T1X1
Percent OCC classifications in this strength category	16.0%	4.5%	27.8%
Total number of women in this strength category	9,619	2,053	13,593
Percent women in this strength category	17.9%	5.95%	26.5%

NOTE ON TABLE C-4: Army defines medium strength requirement as ability to lift on occasional basis a maximum of 50 lb (23 kg) with frequent or constant lifting in excess of 25 lb (11 kg). Corresponds to Navy's moderate/low and Air Force's moderate requirements.

TABLE C-5 Military Occupational Specialty Classification Table: Enlisted Job Classifications with Light Strength Requirements for Women in the Services as of September 1996

	Service Branch—OCC Classification Number		
DoD OCC Classification Number	Army	Navy	Air Force
012 Military Training Instructor			3P1X0, 3P1X1, 8B000, 8B100, 8T000
050 Air Crew, General			8S100
061 Navigators		QM	
100 Radio/Radar General		ET	
102 Navigation, Communications			2A1X0, 2A1X1
104 Surveillance/Target Acquisition and Tracking Radar			2E4X1
121 Missile Guidance and Control			2M0X0, 2M0X1, 2M0X3
122 Missile Checkout Equipment			2E8X0, 2E8X1
130 Sonar, General		OTA, OTM, STG, STS	
140 Nuclear Weapons Equipment Repair			2W2X0, 2W2X1
150 Automated Data Processing Computers, General		DS	
198 Electronic Instruments			2A0X0, 2A0X1, 2A1X4
201 Radio Code		RM	1A3X0, 1A3X1, 1A5X0, 1A5X1
203 Nonradio Communications (Visual)		SM	
221 Radar		OS	1A4X0, 1C5X0, 1C5X1, 1C6X1, 1C6X0, 1A4X1
222 Air Traffic Control		AC	1C1X0, 1C1X1

Continued

TABLE C-5 *Continued*

DoD OCC Classification Number	Service Branch—OCC Classification Number		
	Army	Navy	Air Force
230 Signal Intelligence/Electronic Warfare, General		EW	
231 Intercept Operators	98K	CTR, CTT	
232 Analysis		CTI	1N2X0, 1N2X1, 1N4X1
233 Electronic Countermeasures			1N6X1
241 Language Interrogation, Interpretation	97E		8D000, 9L000, 1N3X0, 1N3X1, 1N3X2, 1N3X3, 1N3X4, 1N3X5
242 Image Interpretation		IS	1N0X0, 1N0X1, 1N1X1
250 Combat Operations Control, General			1C3X0, 1C3X1
260 Communications Center, Operations, General		CTO	
300 Medicare Care and Treatment, General			4H0X0, 4H0X1
301 Surgery			4N1X1
302 Behavioral Sciences (Mental Health)			4C0X0, 4C0X1
303 Therapy			4J0X0, 4J0X1, 4J0X2
304 Orthopedic			4U0X1
311 Biomedical Laboratory Services			4T0X0, 4T0X1, 4T0X2, 4T0X3
323 Ophthalmology, Optometry			4V0X0, 4V0X1

Continued

TABLE C-5 *Continued*

DoD OCC Classification Number	Service Branch—OCC Classification Number		
	Army	Navy	Air Force
324 Physiology			4M0X0
325 Diet Therapy			4D0X0, 4D0X1
326 Biomedical Equipment Maintenance and Repair			4A2X0, 4A2X1
330 Dental Care, General		DT	4Y0X0, 4Y0X1
331 Dental Laboratory			4Y0X2
340 Medical Administration			4A0X0, 4A0X1
400 Photography, General		PH	3V0X0, 3V0X1
411 Mapping	81C		
412 Surveying			3E5X1
420 Weather, General		AG	
450 Musicians, General	02B, D, G, J		3N1X0, 3N1X1, 3N2X0, 3N2X1
493 Safety			150X0, 150X1
496 Other Technical Specialists and Assistants			8E000
500 Personnel, General		PN	3S0X0, 3S0X1, 3S0X2, 3U0X1, 8C000, 340X0, 3E6X1
501 Recruiting and Counseling			3S1X0, 3S1X1, 8R000
510 Administration, General		CTA, YN	3A0X0, 8P100, 3A0XI
512 Legal			5J0X0, 5J0X1
521 First Sergeants, Sgt Major, Leading Chiefs			8F000, 8S000, 9C000, 9E000

Continued

TABLE C-5 *Continued*

DoD OCC Classification Number	Service Branch—OCC Classification Number		
	Army	Navy	Air Force
531 Data Processing, Operators, Analysts		DP	
532 Programmers			3C0X0, 3C0X1, 3C0X2, 3C1X2
541 Auditing and Accounting	73D		6F0X0, 6F0X1
542 Disbursing	73C	DK	6F0X2
551 Supply Administration			2G0X0, 2S0X0, 6C0X0, 6C0X1, 2G0X1, 2S0X1, 2S0X2
553 Transportation			8A000
555 Aviation Maintenance and Reports		AZ	
556 Flight Operations			1C0X0, 1N5X0, 1C0X1, 1C0X2
558 Functional Analysis			2R0X0, 3C3X1, 6F1X0, 6F1X1, 2ROX1
561 Chaplains Assistant			5R0X0, 5R0X1
570 Information and Education, General	46Q, R	JO	3H0X0, 3N0X0, 3H0X1, 3S2X0, 3S2X1, 3N0X1
670 Precision Equipment, General		IM	
700 Metalworking, General			2A7X0, 2A7X1
720 Utilities, General			3E4X2
740 Lithography, General			3R0X0, 3R0X1
760 Fabric, Leather, and Rubber, General			2A7X2

Continued

TABLE C-5 *Continued*

DoD OCC Classification Number	Service Branch—OCC Classification Number		
	Army	Navy	Air Force
801 Stewards and Enlisted Aides			9G000
811 Motor Vehicle Operators			2T3X2, 2T3X3
830 Law Enforcement, General			8G000
832 Investigations			7S0X0, 7S0X1
Percent OCC classifications in this strength category	56.0%	41.7%	55.1%
Total number of women in this strength category	1,780	15,178	32,997
Percent women in this strength category	3.3%	44.0%	64.4%

NOTE ON TABLE C-5: Army defines light strength requirement as ability to lift on occasional basis a maximum of 20 lb (9 kg) with frequent or constant lifting of 10 lb (5 kg). Corresponds to Navy's low/moderate and low/low and Air Force's low requirements.

NOTES ON TABLES C-1 to C-5: For Marines and Coast Guard, job classifications are not subject to strength testing; therefore, strength level categories cannot be assigned. As female military personnel are not permitted to serve in designated combat or combat-related assignments, these military occupational specialties have not been included in this table. DoD, Department of Defense; OCC, occupational codes.

SOURCE FOR TABLES C-1 to C-5: *Army*: Adapted from Sharp et al. (1980) and MAJ Kurt Berry (U.S. Total Army Personnel Command, Alexandria, Va.); *Navy*: Adapted from DoD 132.1-I (1995) by LT Leslie Cox (Bureau of Naval Personnel, [BUPERS] Washington, D.C.) and Ross Vickers (Naval Health Research Center, San Diego, Calif.). Air Force: Adapted from Air Force Specialty Code, including Air Force Manual 36-2108, attachment 39, by MAJ Joanne M. Spahn (Nutritional Medicine Service, 3rd Medical Group/SGSD, Elmendorf AFB, Alaska).

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D

Search Strategy for Literature Review

DETERMINATION OF TOPIC AREAS

Based on extensive discussions among members of the Committee on Body Composition, Nutrition, and Health of Military (BCNH committee) about the statement of task and on the workshop held in Irvine, California, in September 1996, the committee designated four areas into which to divide the task and divided itself into four working groups. These areas/working groups were (1) body composition and fitness; (2) women's nutrition and physical activity; (3) reproductive function, pregnancy, and lactation; and (4) survey methodologies for nutrition and eating disorders.

FORMULATION OF SEARCH TERMS

Lists of search terms were drafted by the staff based on the lists in *Recommendations for Research on the Health of Military Women* (IOM, 1995), which contained an extensive bibliography and the search strategies used to obtain it. These lists were augmented by the committee working groups.

SEARCHES OF BIBLIOGRAPHIC DATABASES

The National Academy of Sciences library staff, with the input of committee staff, performed searches of the following on-line bibliographic databases for the years 1991 to 1996 inclusive, using the correct terminologies for the databases in question and supplying delimiters: Medline, Psychinfo, Sport Database, National Technical Information Service (NTIS), and Defense Research On-line System (DROLS)/Defense Technical Information Center (DTIC) Work Unit and Technical Report databases. Relevant material published prior to 1991 was obtained by drawing upon the 1995 Institute of Medicine (IOM) report mentioned above, the Committee on Military Nutrition Research report on *Body Composition and Physical Performance* (IOM, 1994), the IOM report on *Nutrition during Pregnancy and Lactation* (1990), as well as the expertise of the BCNH committee.

These searches were supplemented with a number of additional small searches of Medline, the General Accounting Office (GAO) database, the Bureau of Labor Statistics on-line site, Federal Research in Progress, and the National Institutes of Health Computer Retrieval of Information on Scientific Projects (CRISP) System.

SELECTION OF RELEVANT CITATIONS

Author and title citations were obtained initially and screened by staff. Because of considerable overlap among three of the topic categories, many citations appeared in more than one search. The initial screening considered only the apparent relevance of the topic to the report. Obvious animal studies were eliminated, as were studies of pediatric and geriatric nutrition, and studies on breast cancer. Abstracts were obtained for titles that were deemed worthy of consideration and were sent to BCNH committee members in the appropriate working groups. Committee members designated abstracts for which they wanted full articles. This judgment was based largely if not solely on topic.

Although the BCNH committee initially considered the application of a set of criteria to inclusion of materials for review, it was determined that because of the limited number of military studies of relevance to the topics, all relevant military materials would be included for consideration and their limitations discussed, if necessary. Civilian literature was included as background and supporting material; wherever possible, critical reviews of the civilian literature were drawn upon to provide this background.

ADDITIONAL SEARCHES AND REQUESTS FOR MATERIAL

Additional reference citations were provided by the speakers at the September 1996 workshop; representatives of the Army, Navy, and Air Force (Offices of the Deputy Chiefs of Staff for Personnel and for Manpower and Reserves, Armstrong Laboratory at Brooks AFB, Defense Manpower Data Center, Naval Health Research Center, U.S. Army Center for Health Promotion and Preventive Medicine, U.S. Army Physical Fitness School, U.S. Army Research Institute of Environmental Medicine, U.S. Army Research Laboratory,); the Defense Advisory Committee on Women in the Services (DACOWITS); presenters at the 1996 Defense Women's

Health Research Program (DWHRP)-sponsored symposium on the health of military women; presenters at the 1996 Women's Research and Education Institute-sponsored workshop on women in uniform; individuals contacted for information on their fire or law enforcement service; Women in the Fire Services; the National Fire Protection Association; the American College of Sports Medicine; as well as the Canadian Forces.

TYPES OF MATERIAL CONSIDERED

The following types of material were included in the report: military policies, directives, instructions, and educational materials; military technical reports of completed research; a small number of interim reports describing proposed or on-going research; DWHRP abstracts of proposed research; reports of original research published in peer-reviewed journals; comprehensive reviews of civilian research; meeting abstracts; IOM reports; GAO reports; civilian fire and law enforcement policy documents; symposia proceedings; and demographic and health status data from the Defense Manpower Data Center (not all requested information was available).

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E

Civilian Inquiry Letter and Table of Responses

A sample letter of inquiry that was sent to civilian service organization follows, along with the table of responses from law enforcement and firefighting organizations. The responses are summarized in Chapter 3 of the report.

INSTITUTE OF MEDICINE
NATIONAL ACADEMY OF SCIENCES
2101 CONSTITUTION AVENUE, N.W. WASHINGTON, DC 20418

FOOD AND NUTRITION BOARD
COMMITTEE ON BODY COMPOSITION, NUTRITION,
AND HEALTH OF MILITARY WOMEN

(202) 334-1737
FAX (202) 334-2316

June 9, 1997

The Food and Nutrition Board of the National Academy of Sciences/Institute of Medicine has a contract with the U.S. Army to provide a set of recommendations regarding the following: body weight standards for active duty military women, physical fitness standards for military women, and policies regarding weight loss and resumption of physical fitness testing after pregnancy. In formulating these recommendations, we are trying to compile a representative sample of comparable standards for women in other physically-active types of uniformed service such as police forces, firefighting services, emergency medical service, Secret Service, forestry service, and overseas military organizations. We would be extremely grateful if you would be willing to share information with us regarding whether your service maintains any of the types of standards or enforces any of the types of policies described. If you represent a number of services, please consider the range of policies you have observed.

Specifically, we would like you to consider the following questions:

I. Weight/Height Standards

Does you service require applicants or those currently employed to adhere to weight/height requirements or other body composition requirements?

If so, what are they? Are they age-specific? gender-specific?

If you know of a source or reference for your standards, what is it? Is *your* policy a written (formal) one?

If you measure body composition (body fat) in a way other than by weight and height (body mass index), what method do you use? Who does that measurement? (a fitness specialist? nurse? other?)

How often are current employees required to be weighed or measured?

If an employee is found to be over the standard for weight or fat, what is the procedure? (formal program? informal program? nutrition counseling? how long before reweighing? consequences?)

Does your service provide a nutrition education program of any type?

II. Physical Fitness Standards

Does your service require applicants and/or current employees to pass a physical fitness test?

If so, what are the components of the test; what constitutes "passing" (is it different according to gender or age or job description)?

How often must the test be taken by current employees?

If there is a source for your physical fitness test, what is it?

Is your policy regarding fitness testing a written one?

If an employee fails the test, what is the procedure? (How long does she/he have before being allowed/required to take it again? Is there a penalty for failing?)

III. Pregnancy Standards

Does your service have a formal policy regarding pregnant employees?

If so, what duty restrictions are imposed and at what stage of pregnancy? (Is there a consequence in terms of salary or promotion potential?)

Are pregnant employees waived from fitness requirements?

If your service has weight or fitness standards, how long are women given after delivery to return to compliance with weight and fitness standards? to return to full duty?

IV. Demographics

What percentage of your employees are women (if this is a service organization, about what percentage of your members or the employees in your area are women) and what is the size of your staff?

What is the average age of the women on your staff?

We realize that we have asked many questions, but this information is extremely valuable and crucial to us as it will help shape our response to the Army's request. Hence, your willingness to respond will help to influence policy for all the military. Please take a few minutes to answer the questions or pass the questionnaire along to those in your service who might be able to supply the answers. Or, if you believe there is another service or organization that would be able to supply us with more useful information, please forward the letter to them. You may fax your responses to us at the above fax number, email them to sydne@nas.edu, or if we do not hear from you, we will follow up with a call in a week. Thank you very much!

Sincerely,

Sydne J Newberry

Sydne Jennifer Newberry, Ph.D.
Program Officer

TABLE E-1 Body Composition, Fitness, and Task Performance Assessment among Civilian Law Enforcement and Fire Services

	Recruitment Assessments			Retention Assessments			
	Body Composition	Fitness	Task Performance	Body Composition*	Fitness	Task Performance	Regular Training Requirement
Law enforcement							
Alexandria, VA	✓	✓†	No	✓?	✓†‡	No	N/A
Arlington Cty, VA							
Dade Cty, FL	No	No	No	No	No	No	N/A
Fairfax Cty, VA	No	✓	✓	No	✓	✓	N/A
Illinois, State of	✓?	✓?	✓?	✓	✓	✓	N/A
Maryland, State of (training ctr)	No	✓†	✓?	No	✓†	✓?	N/A
Montgomery Cty, MD	No	✓	No	No	✓‡	No	N/A
Ontario, Canada	✓	✓	No	No	No	No	N/A
RCMP	✓	✓	✓	✓	✓	✓	N/A
Washington, DC	✓	✓	✓	✓	No	No	N/A
U.S. National Park Service	✓§	✓	No (under re-vision)	✓§	✓‖	No	N/A
U.S. FBI	✓	✓	No	No	✓‖#	No	N/A
U.S. Marshalls	No	✓	No	No	✓	No	Yes

Fire services							
Alexandria, VA	✓	✓	No	✓	✓	✓	N/A
Arlington Cty, VA	✓	✓	Yes (w/in 1 year of training completion)	✓	✓	No	✓
Fairfax Cty, VA	✓§	✓	No	✓§	✓	In progress	N/A
Montgomery Cty, MD	N/A	N/A	N/A	N/A?	✓	✓	N/A
Pike Township, IN	✓§	✓	✓	✓§	✓	✓	✓
Seattle, WA	✓§	✓	N/A?	✓§	✓	N/A?	✓
Washington, DC							
U.S. Forest Service	No	✓	Test development in progress	No	✓	In progress	✓

NOTE: N/A, not available; Cty, County; Ctr, Center; RCMP, Royal Canadian Mounted Police; U.S. FBI, U.S. Federal Bureau of Investigation.

* Annual unless specified.
† Voluntary.
‡ Treadmill test only.
§ Body composition part of fitness test/score.
‖ Semiannual.
Score for personal information only (does not carry consequences).

F

Abbreviations

ACOG	American College of Obstetricians and Gynecologists
ACSM	American College of Sports Medicine
AFB	Air Force Base
AFI 40-502	Air Force Instruction 40-502
AFMAN 44-144	Air Force Manual 44-144
AFPAM 44-125	Air Force Pamphlet 44-125
AFPD 40-5	Air Force Policy Directive 40-5
AIT	Advanced Individual Training
AR 600-9	Army Regulation 600-9
ARI	U.S. Army Research Institute
ARL	U.S. Army Research Laboratory
BCNH committee	Committee on Body Composition, Nutrition, and Health of Military Women
BCT	[Army] basic combat training
BIA	bioimpedance analysis
BMC	bone mineral content
BMD	bone mineral density
BMI	body mass index
BUMED	[Navy] Bureau of Medicine and Surgery

BUPERS	Bureau of Naval Personnel
CDC	Center for Disease Control and Prevention
CMNR	Committee on Military Nutrition Research
COMDTINST M1020.8	[Coast Guard] Commandant Instruction M1020.8C
CPTs	criterion performance tasks
DACOWITS	Defense Advisory Committee on Women in the Services
DBSS	*Dieting and Bingeing Severity Scale*
DHHS	U.S. Department of Health and Human Services
DoD	Department of Defense
DROLS	Defense Research On-line System
DSM-IV	*Diagnostic and Statistical Manual of Mental Disorders, 4th ed.*
DTIC	Defense Technical Information Center
DWHRP	Defense Women's Health Research Program
DXA	dual-energy x-ray absorptiometry
EDI	*Eating Disorders Inventory*
FFM	fat-free mass
FM 21-20	[Army] Field Manual 21-20
FSH	follicle-stimulating hormone
HAZMAT	hazardous materials
IOM	Institute of Medicine
LH	luteinizing hormone
MAJCOM	Major Command
MCO 500.12D	Marine Corps Order 500.12D
MEPSCAT	military entrance physical strength capacity test
MOPP	Mission Oriented Protective Posture
MOS	military occupational specialty
MRDAs	Military Recommended Dietary Allowances
NAVADMIN 148/94	Naval Administrative Message 148/94
NAVOP 064/90	Naval Operational Message 064/90
NHANES	*National Health and Nutrition Examination Survey*
NIDDM	noninsulin-dependent diabetes mellitus
NIH	National Institutes of Health
NRDEC	Natick Research, Development and Engineering Center
NTIS	National Technical Information Service
OCC	occupational classification
OPNAVINST 6000.1A	Naval Operations Instruction 6000.1A
PFA	physical fitness assessment
PFT	physical fitness test
POPAT	*Police Officers' Physical Abilities Test*
PPA	physical performance assessment
PRT	physical readiness test
POWR'95	*1995 Perceptions of Wellness and Readiness Assessment*
RDAs	Recommended Dietary Allowances

USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAMRMC	U.S. Army Medical Research and Materiel Command
USARIEM	U.S. Army Research Institute of Environmental Medicine
USDA	U.S. Department of Agriculture
VDR gene	vitamin D receptor gene

G

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