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LONGITUDINAL TRENDS AND GENDER DIFFERENCES IN PHYSICAL FITNESS AND LIFESTYLE FACTORS IN CAREER U.S. NAVY PERSONNEL (1983-1994)

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Executive Summary

Background

It has been estimated that more than 40% of all illness and premature death in the United States is directly related to personal lifestyle choices, particularly tobacco and alcohol use, fatty diet, and lack of exercise. The U.S. Navy has a keen interest in reducing costly diseases of lifestlye, as well as in meeting the demand that its fighting force be fit, healthy, and ready to perform at all times. To this end, in the early 1980s, the Navy established a comprehensive Health and Physical Readiness (HAPR) Program for all active-duty members. This report analyzes longitudinal trends in the health and fitness of Navy personnel over the ensuing decade.

Approach

Lifestyle questionnaires, body composition measurements, and Physical Readiness Test (PRT) performance scores were obtained for all participants from several baseline HAPR studies between 1983 and 1989 who were still on active duty in 1994. Two longitudinal cohorts were created: an 8-year sample (N = 640), with matched data from 1986, 1989, and 1994; and an 11-year sample (N = 1,576), with data from 1983 and 1994. Data were analyzed for overall trends as well as for gender differences in physical fitness and lifestyle behaviors.

Results

In both the 8-year and 11-year cohorts, significant improvements were observed in physical fitness, exercise activity, lean body mass, dietary habits, and sleep, and there were significant decreases in tobacco and alcohol use and job stress. Thus, despite being 8 to 11 years older, the participants evidenced many improvements in their fitness level and lifestyle habits. Hypertension rates, body mass index, and percent body fat all showed significant increases over time, however. Women's scores were significantly better than men's on a number of factors, including dietary choices and intake, body mass index, job stress, alcohol use, and hypertension rates.

Conclusions

Being longitudinal in nature, this study sample is not representative of the Navy as a whole, but rather of the somewhat older, higher-ranked, career men and women whose lives have been subject to influence for more than a decade by the Navy's health promotion efforts. Replication of results across the two cohorts supported the generalizability of the findings to such personnel. Overall, these results suggest that the Navy's health promotion initiatives have had a significant positive impact on the health and fitness of career Navy personnel.

Longitudinal Trends and Gender Differences in Physical Fitness and Lifestyle Factors in Career U.S. Navy Personnel (1983 - 1994)

Introduction

It has been estimated that more than 40% of all illness and premature death in the United States is directly related to personal lifestyle choices, particularly tobacco and alcohol use, fatty diet, and lack of exercise.[1,2] Since the early 1980s, worksite health promotion programs have become increasingly common, as industries of every type attempt to improve the health and productivity of their employees and curtail rising health care costs—often with significant success.[3,4] While preventive interventions generally are expected to reap both financial and life quality dividends, neither outcome is assured, and most companies recognize the importance of program evaluation as an integral part of their health promotion efforts.

With nearly half a million people on their active payroll, and more than one million retirees and dependent family members who are also health care beneficiaries, the U.S. Navy constitutes one of the nation's largest employers offering health care coverage to its personnel.[5] As such, the Navy has a keen interest in reducing costly diseases of lifestyle, as well as in meeting the demand that its fighting force be fit, healthy, and ready to perform at all times. Therefore, in October 1982, the Navy established a comprehensive Health and Physical Readiness (HAPR) Program to promote health and physical fitness, set minimum standards for fitness and weight control, and emphasize the need for all active-duty personnel to participate in lifestyle behaviors that promote good health.[6] The program targeted seven lifestyle elements: exercise and physical fitness, tobacco use, alcohol and drug use, nutrition and weight/fat control, stress management, hypertension, and back injury prevention.

Over the ensuing decade, the Navy developed and modified specific health promotion programs—some of them educational, others active interventions—to address these lifestyle behaviors. And beginning in 1983, the Naval Health Research Center conducted a number of evaluation studies to assess the efficacy of specific program elements. Three of these investigations are especially pertinent to the present report. The first, a baseline analysis of the new HAPR Program, examined Physical Readiness Test (PRT) scores and anthropometric measurements for approximately 6,000 active-duty Navy men and women at 22 shore commands in 1983.[7] The second provided lifestyle data for about 1,300 men, and fitness and body composition measurements for about 4,000 men, stationed aboard 9 Navy ships in 1984.[8] The third was a series of four annual assessments conducted between 1986 and 1989. Based initially on a command-stratified, random sample of active-duty personnel Navywide, this longitudinal study preserved sample size by randomly replacing targeted participants who had left their commands.[9] This approach resulted in PRT and/or lifestyle information for almost 10,000 individuals, including several hundred who provided data at more than one time period.

The present study was a follow-up of participants in these original HAPR evaluations between 1983 and 1989. The purpose was to document longitudinal trends in fitness and health behaviors among Navy personnel over the last decade, as well as to provide the kind of data needed to test hypotheses concerning health behavior change, predictors of change, and the relationships among health behaviors, morbidity, and performance. This is the only research, to our knowledge, to provide long-term longitudinal trend data concerning a variety of health behaviors and fitness measures for Navy personnel (the well-known Department of Defense Worldwide Survey[10] provides cross-sectional trend data only and focuses on substance use). Results from this study will be presented in a series of reports. The present report describes trends in physical readiness and lifestyle factors in two longitudinal Navy cohorts.

Method

Procedure

We mailed lifestyle questionnaires to all participants from six earlier HAPR evaluation studies (in 1983, 1984, 1986, 1987, 1988, and 1989) who were still on active duty in the fall of 1994. In addition, we asked the targeted participants' Command Fitness Coordinators (CFCs) to provide 1994 PRT scores and percent body fat measurements for the individuals. Members who had transferred to another command during the mailout period were followed up at their new commands. We sent a courtesy reminder and another set of forms to anyone who had not responded within 8 weeks.

Sample

Of nearly 20,000 Navy personnel who had provided data in one or more of the earlier studies, 5,539 were identified as still on active duty in 1994; these individuals constituted the targeted sample. While the overall response rate was high (82%), most of the respondents had matching data from only one of the earlier studies, and virtually none had data from more than two other studies. To maximize the usability of this large but time-dispersed sample for examining longitudinal trends, the following procedure was used. First, the six earlier studies were consolidated into three large data sets: 1983 to 1984, 1986 to 1987, and 1988 to 1989. If the same individual had provided data in both years of a consolidated set, his or her data were retained for 1 year only (i.e., data from 1983, 1986, and 1989 were retained in the three sets, respectively); the other year was dropped. These baseline databases—hereafter referred to as the 1983, 1986, and 1989 studies—were matched with the 1994 follow-up data, and two different longitudinal samples were created for analyses, based on the number of matching data points available. One was an 8-year "trends" sample ($N = 640$), in which all participants had matched records for three data collection periods: 1986, 1989, and 1994. The other was an 11-year "follow-up" sample ($N = 1,576$), with matched data from 1983 and 1994 (all remaining 1994 respondents had earlier data from 1986 only, or 1989 only, and were not included in either cohort). Except for 10 individuals who were in both samples, the two cohorts did not overlap. Within the 8-year cohort, 586 participants had provided PRT/body composition data, and 561 had returned lifestyle questionnaires; within the 11-year cohort, 1,533 had PRT/body composition data, and 275 had survey data. Because the 1983 lifestyle questionnaire had been

administered to shipboard personnel only (which at that time did not include women), survey data were not available for women in the 11-year cohort.

Instruments

The 1994 lifestyle questionnaire was a 9-page, self-administered survey designed to assess a wide variety of health-related behaviors, attitudes, and perceptions. Areas of interest for this report included physical activity, diet, tobacco and alcohol use, sleep, job stress, blood pressure, and self-perceived health. Questionnaire items were derived largely from the surveys used in the earlier HAPR studies so that matching data would be available. CFCs obtained physical fitness scores (run, sit-ups, push-ups) and body fat measurements during the 1994 PRT cycle and reported them on a separate form.

Measures

Body Composition

Percent body fat (%BF) was determined by measuring specified body circumference landmarks with a tape measure and computing the percentage of fat using equations developed for that purpose.[11-14] In 1983 and 1986, female body fat was based on five circumference measurements: abdomen, neck, forearm, bicep, and thigh; in 1989 and 1994, the sites were changed to the waist, neck, and hip. Male body fat was based on abdomen and neck measurements in every study. The equations used in 1983 and 1986 were based solely on circumference measurements;[11,12] in 1989 and 1994, the modified equations included height in the calculations.[13,14] Relative to underwater weighing, the earlier equations tended to slightly underpredict %BF for men in the middle range of %BF values (roughly 18%-28%) and for women above 22%; the later equations corrected this.[13,14]

Using %BF as a basis, we calculated lean body mass (LBM) using the formula LBM = weight x (100 - %BF) ÷ 100. Body Mass Index (BMI) was computed as BMI = weight (in kilograms) ÷ height^2 (in meters). Body composition analyses also included two variables indicating the percentage of participants who exceeded (1) the BMI standards of 27.8 for men and 27.3 for women (above which an individual is considered to be overweight), and (2) the Navy's percent body fat standards of 22% fat for men, 30% fat for women (above which a member is classified as overfat/obese).

Physical Fitness

Physical fitness was operationalized in terms of physical performance scores on the 1.5-mile run (cardiorespiratory endurance), sit-ups (muscular endurance), and push-ups tests (upper body strength). The push-ups test was not part of the PRT in 1983, so scores on this test were available for the 8-year sample only. Standardized procedures for the PRT tests are described in the Navy's Physical Readiness Program Instruction.[15] The tests are scored as the amount of time required to run 1.5 miles, the number of sit-ups completed in 2 minutes, and the number of push-ups performed in 2 minutes. Using the Navy's PRT point table,[15] raw scores are transformed into age- and sex-

adjusted classification scores, wherein 0 = Fail, 1 = Satisfactory, 2 = Good, 3 = Excellent, and 4 = Outstanding. Analyses in the present report are based on these standardized classification scores.

Physical Activity

An estimate of total kilocalories (kcals) expended per week in physical exercise was computed for each participant, based on his or her self-reported frequency (sessions per week) and duration (minutes per session) of engaging in each of nine physical activities (e.g., running, bicycling, calesthenics) listed in the questionnaire. Using tables of energy expenditure from McKardle, Katch, and Katch,[16] we assigned kcals expended per minute to each type of physical activity. An adjustment factor based on the individual's body weight was used in calculating each participant's kcals. Thus, total weekly energy expenditure = (weight-adjusted kcals per activity) x (min/wk spent in that activity), summed across all nine activities.

Sleep

Participants simply reported the number of hours that they usually slept per night.

Dietary Practices

We examined four dietary variables: frequency of eating breakfast, snacking between meals, overeating, and quality of overall dietary intake. The first three variables were scored on a 5-point scale ranging from 0 (*Never this week*) to 4 (*7 or more times this week*). The overall dietary intake score was based on the reported number of servings per week of 14 different types of food (e.g., high fat meats, whole grains). First, we divided the food choices into "good" (healthful) selections, such as fruits, vegetables, and low-fat foods, and "poor" (less healthful) choices, such as high-fat meat and dairy products, refined sugars, and fried foods. Then the average number of servings per week of both good and poor food selections was calculated for each person. We computed the overall diet score by subtracting the mean "poor" score from the mean "good" score; thus, the higher the overall diet score, the better the dietary choices.

Substance Use

Participants classified themselves as either smokers (light, moderate, or heavy) or nonsmokers; responses were dichotomized (smoker/nonsmoker) for analyses. Average weekly alcohol intake was calculated by multiplying the number of days on which the respondent reported drinking alcohol "during the last 7 days" by the usual number of drinks consumed on those days.

Job Stress

Two composite scales were created to indicate the amount of stress a member experienced while at work. The scales were adapted from Caplan et al.,[17] who originally used the items to assess job performance in self-medicators. The first scale, Job Stress, was composed of two Likert-type items

that queried (1) "How much stress do you feel in your job?" and (2) "Relative to others in the Navy, do you feel that your job is more or less stressful?" Responses ranged from 1 (*None at all*) to 5 (*A great deal*) on the first item and from 1 (*Very much less*) to 5 (*A great deal more*) on the second. Thus, the higher the Job Stress score, the more stress was perceived at work. Cronbach's alpha coefficients[18] for the composite were .67, .71, and .68 in the 1986, 1989, and 1994 surveys, respectively; the two job stress items had not been included in the 1983 questionnaire.

The second scale, Managing Demands, comprised five Likert-type items that asked how well the respondent was handling work demands, meeting deadlines, getting along with coworkers, performing without mistakes, and making the right decisions at work. Responses ranged from 1 (*Very poorly*) to 6 (*Extremely well*) on all five items. A higher score on Managing Demands reflected better coping (and therefore, presumably, less stress). Alpha coefficients for the composite were .86, .89, and .89 for the 1986, 1989, and 1994 time periods, respectively; again, the items were not part of the 1983 survey.

High Blood Pressure

Respondents were asked whether a doctor had ever told them that they had high blood pressure (*Yes/No*), and, if so, whether it was currently controlled within normal limits.

Self-Perceived Health

Self-perceived health has been shown to be a useful measure of health status.[19] This variable was assessed by a single item, "How would you rate your current health?" Response options ranged from 1 (*Poor*) to 5 (*Excellent*), so that a higher score indicated greater perceived health.

Statistical Analyses

Bivariate analyses of differences between means in the 11-year sample were performed using two-tailed *t*-tests for matched pairs (time analyses) or independent groups (sex analyses). Multivariate analyses of time trends in the 8-year sample were tested with multivariate analysis of variance (MANOVA)[20] using SPSS-X.[21] Sex differences in the 8-year cohort, and sex-by-time interactions in both cohorts also were analyzed using MANOVA procedures. Dichotomous variables are reported here as percentages; differences over time or between groups were tested for significance using chi-square analysis for matched samples[22] or analysis of variance for categorical variables.[23]

Results

Response Rates

We calculated follow-up response rates separately for each cohort by dividing the number of respondents in the cohort by the total number of targeted participants who were eligible for inclusion

in the cohort (that is, they had provided data either in 1983, or in both 1986 and 1989). The resulting rates were quite high: 96.7% for the 8-year sample, 91.8% for the 11-year group. Such rates would appear to preclude any response bias within the two samples. However, because the two cohorts and their respective pools of cohort-eligible participants constituted a selected subset of the entire targeted follow-up sample, we performed one further analysis. All respondents in the two cohorts combined ($N = 2,206$) were compared demographically with all targeted sample nonrespondents ($N = 994$), including those who could not be contacted at follow-up because of discharge or decommissioning that occurred after follow-up data collection had been initiated. These analyses revealed that the cohort respondents were slightly older and more educated than nonrespondents, with a higher proportion of whites and officers; the groups did not differ on sex.

Sample Demographics

Table I describes the demographic composition of the two trends samples at follow-up. The 11-year cohort, about half of whom were shipboard men at baseline, presented a significantly older, nonwhite, enlisted, male profile relative to the 8-year cohort. Descriptive data for the total Navy, which are included in Table I, show that respondents in both longitudinal samples were generally older and better educated than the average sailor. This is to be expected, since aging and age-related development are inherent in cohort samples; however, at baseline, the participants were part of representative Navy samples.

TABLE I

DEMOGRAPHIC COMPOSITION OF TWO U.S. NAVY LONGITUDINAL SAMPLES IN LATE 1994, AND THE TOTAL U.S. NAVY IN EARLY 1995

Variable	8-Year Cohort ($N = 640$)	11-Year Cohort ($N = 1,576$)	$p \leq$ [a]	U.S. Navy[b] ($N = 580,007$)
Age (mean y)	36.8	37.4	.01	28.6
Sex (%)			.001	
Men	87.0	92.5		87.9
Women	13.0	7.5		12.1
Race (%)			.001	
White	83.3	72.6		77.1
Black	12.7	11.6		16.8
Other	4.1	15.9		6.1
Rank (%)			.001	
Enlisted	79.8	86.9		85.7
Officer	20.2	13.1		14.3
Education (%)			n.s.	
< 12 y	.9	1.6		4.6
12 y	36.6	37.2		73.9
> 12 y	62.5	61.2		21.5

[a] p values for 8-year versus 11-year cohort comparisons calculated by t-test or chi-square test.
[b] Total Navy demographics are presented for descriptive purposes and were not analyzed statistically.

Trends in Body Composition

Table II summarizes trends in %BF, LBM, BMI, percentage of overweight personnel (exceed BMI standards), and percentage of overfat personnel (exceed %BF standards) in the two cohorts.

TABLE II

TRENDS IN BODY COMPOSITION (MEAN AND STANDARD DEVIATION) IN TWO U.S. NAVY COHORTS, OVER 8 YEARS AND 11 YEARS, BY SEX

		8-Year Cohort							11-Year Cohort					
						$p \leq$						$p \leq$		
Variable	Group	*N*	1986	1989	1994	Time	Sex	S x T	*N*	1983	1994	Time	Sex	S x T
% Body Fat[a]	Men	336	15.0 (4.8)	16.1 (5.0)	17.4 (4.5)	.001			1090	16.4 (10.3)	17.3 (4.5)	.01		
	Women	56	19.8 (3.9)	23.2 (5.4)	23.6 (6.3)	.001			97	20.7 (5.1)	23.9 (5.8)	.001		
	Overall	392	15.7 (5.0)	17.1 (5.7)	18.3 (5.3)	.001	.001	.001	1187	16.7 (10.1)	17.9 (4.9)	.001	.001	.05
LBM[b] (lbs)	Men	218	148.1 (18.5)	148.6 (17.5)	154.0 (17.7)	.001			724	141.4 (20.1)	150.6 (19.4)	.001		
	Women	34	106.0 (11.0)	104.7 (9.4)	108.4 (12.0)	.01			79	105.0 (11.0)	106.8 (10.1)	n.s.		
	Overall	252	142.4 (22.8)	142.7 (22.4)	147.8 (23.1)	.001	.001	n.s.	803	137.8 (22.1)	146.2 (22.7)	.001	.001	.01
BMI[c] (wt/ht^2)	Men	237	25.1 (3.2)	25.2 (3.0)	26.5 (2.9)	.001			841	24.4 (2.9)	26.1 (3.1)	.001		
	Women	36	21.9 (2.3)	22.6 (2.4)	23.3 (3.0)	.001			85	21.9 (2.2)	22.8 (3.0)	.001		
	Overall	273	24.7 (3.3)	24.9 (3.0)	26.0 (3.1)	.001	.001	n.s.	926	24.2 (3.0)	25.8 (3.2)	.001	.001	.001
Overweight (exceeds BMI standards)[d]	Men	237	17.3 (2.5)	17.7 (2.5)	29.1 (3.0)	.01			841	12.7 (1.1)	25.8 (1.5)	.01		
	Women	36	0.0 (0.0)	2.8 (2.7)	13.9 (5.8)	.01			85	3.5 (2.0)	4.7 (2.3)	n.s.		
	Overall	273	15.0 (2.2)	15.8 (2.2)	27.1 (2.7)	.01	.01	n.s.	926	11.9 (1.1)	23.9 (1.4)	.01	.001	.01
Overfat (exceeds %BF standards)[e]	Men	336	6.3 (1.3)	5.4 (1.2)	6.0 (1.3)	n.s.			1090	7.5 (0.8)	6.1 (0.7)	n.s.		
	Women	56	0.0 (0.0)	5.4 (3.0)	8.9 (3.8)	.05			97	3.1 (1.8)	6.2 (2.4)	n.s.		
	Overall	392	5.4 (1.1)	5.4 (1.1)	6.4 (1.2)	n.s.	n.s.	n.s.	1187	7.2 (0.8)	6.1 (0.7)	n .s.	n.s.	n.s.

[a] Percent Body Fat
[b] Lean Body Mass = weight x (100 - % body fat)/100.
[c] Body Mass Index = weight (kg)/height $(m)^2$.
[d] Percentage and standard error; BMI standards are 27.8 for men, 27.3 for women.
[e] Percentage and standard error; Navy body fat standards are 22% fat for men, 30% fat for women.

Although both men and women showed significant increases in %BF and BMI as they aged, they also exhibited increases in LBM. The percentage of overweight members increased dramatically over the years and was significantly higher among men than among women. Conversely, the percentage of members who exceeded the Navy's body fat standards did not change significantly, nor did the rates differ between men and women. The only exception to these findings was for women in the 8-year cohort, who showed a significant increase in overfat members. It should be noted that the sample size for women is often quite small, and statistically significant changes are not always of practical import. In the present case, for example, the 9% increase in the number of women exceeding standards was accounted for by only five individuals.

Trends in Physical Fitness

Men and women in both samples demonstrated increased physical fitness over the years, measured in terms of age- and sex-adjusted classification scores on the 1.5-mile run, sit-ups, and push-ups tests (Table III). The only exception to this overall improvement was again among women in the 8-year cohort, whose classification score increases for the 1.5-mile run did not reach significance. Men and women did not differ in their PRT scores, except on the push-ups test where women's classification scores were higher.

Classification scores were used in these analyses to control for gender differences in physical performance as well as for physiological changes in muscular strength and endurance that occur with age. Nonetheless, it is informative to examine the PRT raw scores as well (not shown in Table III). Although their classification scores improved, men in both samples exhibited significant decrements in 1.5-mile run times over the years, with average run time increases of 31 to 40 seconds ($p \leq .001$). Women, on the other hand, displayed significant improvement in cardiorespiratory performance in the 8-year sample, paring their average run time by about 26 seconds ($p \leq .05$), while their time remained essentially unchanged in the 11-year group. Both sexes demonstrated significantly augmented muscular strength, reflected in the greater number of sit-ups and push-ups they were able to perform in 2 minutes. In the 8-year cohort, sit-ups increased from 55 to 60 for men ($p \leq .001$), and from 52 to 57 for women ($p \leq .01$); push-ups increased from 40 to 45 for men ($p \leq .001$), 20 to 26 for women ($p \leq .05$) (all figures rounded to the nearest whole integer). In the 11-year cohort, sit-ups increased from 53 to 56 for men ($p \leq .001$), 50 to 55 for women ($p \leq .05$); push-ups were not in the PRT test for this group. Men's raw scores in the 8-year sample were significantly better than women's on the run ($p \leq .001$) and push-ups test ($p \leq .001$), but the sexes did not differ on their sit-ups raw scores.

Trends in Physical Activity and Sleep

As presented in Table IV, overall trends in both physical exercise and sleep displayed a slightly U-shaped curve over the three time periods recorded for the 8-year cohort, dropping slightly in the middle time period (1989) before regaining or surpassing their initial levels. The overall trends were significant, although when men and women were examined separately, the changes over time were

TABLE III

TRENDS IN PHYSICAL READINESS TEST (PRT) CLASSIFICATION SCORES[a] (MEAN AND STANDARD DEVIATION) IN TWO U.S. NAVY COHORTS, OVER 8 YEARS AND 11 YEARS, BY SEX

		8-Year Cohort							11-Year Cohort					
						p≤						*p*≤		
Variable	Group	*N*	1986	1989	1994	Time	Sex	S x T	*N*	1983	1994	Time	Sex	S x T
Run (1.5 mile)	Men	342	2.11 (1.00)	1.99 (.94)	2.15 (.93)	.05			1234	2.00 (1.00)	2.06 (.94)	.05		
	Women	47	1.94 (1.03)	2.13 (1.04)	2.28 (1.10)	n.s.			101	1.68 (.91)	2.19 (1.00)	.001		
	Overall	389	2.09 (1.01)	2.01 (.95)	2.16 (.95)	.01	n.s.	n.s.	1335	1.98 (1.00)	2.07 (.94)	.01	n.s.	.001
Sit-ups	Men	355	1.90 (.93)	2.42 (1.10)	2.63 (1.10)	.001			1248	1.74 (.76)	2.49 (1.07)	.001		
	Women	50	2.14 (1.07)	2.52 (1.04)	2.62 (1.11)	.001			101	1.94 (.90)	2.49 (1.07)	.001		
	Overall	405	1.93 (.95)	2.43 (1.09)	2.63 (1.10)	.001	n.s.	n.s.	1349	1.75	2.49	.001	n.s.	.05
Push-ups[b]	Men	179	1.98 (1.30)	2.32 (1.40)	2.67 (1.40)	.001			—	—	—			
	Women	26	2.35 (1.29)	2.92 (1.16)	3.10 (1.16)	.05			—	—	—			
	Overall	205	2.03	2.40	2.72	.001	.05	n.s.	—	—	—			

[a] PRT classification scores are age- and sex-adjusted. 0 = Fail, 1 = Satisfactory, 2 = Good, 3 = Excellent, 4 = Outstanding.
[b] The 1983 PRT did not include the push-ups test.

TABLE IV

TRENDS IN PHYSICAL EXERCISE AND SLEEP (MEAN AND STANDARD DEVIATION) IN TWO U.S. NAVY COHORTS, OVER 8 YEARS (BY SEX) AND 11 YEARS (MEN ONLY)[a]

		8-Year Cohort							11-Year Cohort (men only)			
						p≤						
Variable	Group	*N*	1986	1989	1994	Time	Sex	S x T	*N*	1983	1994	*p*≤ (Time)
Exercise (kcal/wk)[b]	Men	290	2,268 (2,174)	2,126 (2,501)	2,411 (1,814)	n.s.			222	1,881 (1,329)	2,179 (1,713)	.05
	Women	54	1,410 (1,063)	1,176 (1,465)	1,629 (1,433)	n.s.			—	—	—	
	Overall	344	2,133 (2,063)	1,977 (2,392)	2,289 (1,781)	.05	.001	n.s.	—	—	—	
Sleep (hr/night)	Men	407	6.4 (1.1)	6.3 (1.1)	6.4 (1.1)	n.s.			229	6.3 (1.1)	6.6 (1.0)	.01
	Women	60	6.9 (1.2)	6.7 (1.0)	6.9 (1.1)	n.s.			—	—	—	
	Overall	467	6.5 (1.1)	6.4 (1.1)	6.6 (1.1)	.05	n.s.	n.s.	—	—	—	

[a] The 1983 lifestyle questionnaire was administered to shipboard personnel only, which in 1983 did not include women.
[b] Computed with respect to individual body weight.

not statistically significant. In the male-only 11-year sample, whose baseline (1983) scores were lower than the 8-year male baselines (1986), significant increases occurred in both kcal expenditure and hours of sleep.

Trends in Dietary Practices

The most consistent trend in dietary habits was reflected in the overall diet score. Table V reveals that a highly significant improvement in dietary choices occurred in all groups over the years studied. Women's food choices were healthier than men's; women also reported eating breakfast more regularly and overeating less often than their male counterparts (8-year cohort), whose tendency to overeat had increased somewhat, but who nevertheless exhibited improved breakfast habits. The

TABLE V

TRENDS IN DIETARY HABITS (MEAN AND STANDARD DEVIATION) IN TWO U.S. NAVY COHORTS, OVER 8 YEARS (BY SEX) AND 11 YEARS (MEN ONLY)[a]

		8-Year Cohort							11-Year Cohort (men only)			
						$p \leq$						
Variable	Group	*N*	1986	1989	1994	Time	Sex	S x T	*N*	1983	1994	$p \leq$ (Time)
Breakfast[b]	Men	317	1.89 (1.41)	1.82 (1.39)	2.19 (1.41)	.001			160	1.64 (1.34)	1.74 (1.39)	n.s.
	Women	49	1.98 (1.47)	2.16 (1.55)	2.67 (1.31)	.001			—	—	—	
	Overall	366	1.90 (1.41)	1.86 (1.42)	2.25 (1.41)	.001	n.s.	n.s.	—	—	—	
Snacks[b]	Men	317	1.78 (1.16)	1.77 (1.23)	1.90 (1.43)	n.s.			159	1.72 (1.23)	1.70 (1.33)	n.s.
	Women	47	1.57 (1.18)	1.70 (1.21)	2.07 (1.47)	.05			—	—	—	
	Overall	364	1.75 (1.17)	1.76 (1.22)	1.92 (1.43)	.05	n.s.	n.s.	—	—	—	
Overeat[b]	Men	306	.61 (.91)	.61 (.84)	.74 (.98)	.05			158	.72 (.85)	.66 (.94)	n.s.
	Women	48	.44 (.68)	.40 (.64)	.44 (.68)	n.s.			—	—	—	
	Overall	354	.59 (.88)	.59 (.82)	.70 (.95)	n.s.	.05	n.s.	—	—	—	
Diet[c]	Men	314	-.08 (2.61)	.54 (2.56)	1.47 (2.77)	.001			162	-.23 (2.64)	1.02 (3.06)	.001
	Women	49	1.17 (2.42)	1.84 (2.42)	2.67 (2.72)	.001			—	—	—	
	Overall	363	.09 (2.61)	.71 (2.58)	1.63 (2.79)	.001	.001	n.s.	—	—	—	

[a] The 1983 lifestyle questionnaire was administered to shipboard personnel only, which in 1983 did not include women.
[b] Scored on 5-point scale: 0 = never this week; 1 = 1–2 times; 2 = 3–4 times; 3 = 5–6 times; 4 = 7 or more times this week.
[c] Score computed as the mean number of "good" dietary choices minus the mean number of "poor" choices.

11-year sample of men failed to show any significant changes in their breakfast, snacking, or overeating behaviors, despite demonstrating significantly better food choices in 1994 than they did in 1983.

Trends in Substance Use

Cigarette smoking and alcohol use declined significantly over 8 years among men, particularly in the 11-year shipboard sample, while women showed no change in their use of either substance (Table VI). Although women's smoking rates were lower than men's rates (8-year cohort) at all time periods, and the men's lowest rate (29.5% smokers) was higher than women's highest rate (27.9%), these differences in percentage of smokers were not statistically significant. The sexes did differ in their use of alcohol, however, with women drinking significantly less than men (about 2 drinks per week versus more than 4 drinks per week, respectively, at follow-up).

TABLE VI

TRENDS IN SMOKING AND ALCOHOL USE IN TWO U.S. NAVY COHORTS, OVER 8 YEARS (BY SEX) AND 11 YEARS (MEN ONLY)[a]

		8-Year Cohort							11-Year Cohort (men only)			
						$p \leq$						
Variable	Group	*N*	1986	1989	1994	Time	Sex	S x T	*N*	1983	1994	$p \leq$ (Time)
Smokers[b]	Men	420	36.0 (2.3)	35.5 (2.3)	29.5 (2.2)	.01			234	45.3 (3.3)	30.8 (3.0)	.01
	Women	61	27.9 (5.7)	27.9 (5.7)	26.2 (5.6)	n.s.			—	—	—	
	Overall	481	34.9 (1.41)	34.5 (1.42)	29.1 (1.41)	.01	n.s.	n.s.	—	—	—	
Alcohol use[c] (drinks/wk)	Men	416	7.4 (10.5)	5.9 (9.0)	4.3 (7.9)	.001			235	10.3 (13.5)	5.3 (29.7)	.01
	Women	59	2.1 (3.2)	2.0 (3.9)	2.0 (3.7)	n.s.			—	—	—	
	Overall	475	6.7 (10.1)	5.4 (8.6)	4.0 (7.6)	.001	.001	n.s.	—	—	—	

[a] The 1983 lifestyle questionnaire was administered to shipboard personnel only, which in 1983 did not include women.
[b] Percentage of smokers and standard error.
[c] Mean and standard deviation.

Trends in Job Stress

Table VII describes gender differences in perceived stress and coping abilities on the job. Whereas men reported a steady decline in job stress over the 8 years documented, women reported no change. However, women's overall perceived stress levels were lower than the men's. And while both men and women reported a growing ability to manage their work demands, men's coping

abilities were greater than women's. Thus, although men reported more job-related stress in general, they also reported greater success in coping with job demands, along with a significant reduction in the amount of stress experienced.

TABLE VII

TRENDS IN JOB-RELATED STRESS OVER 8 YEARS IN A LONGITUDINAL NAVY COHORT, BY SEX[a]

						$p \leq$		
Variable	Group	*N*	1986	1989	1994	Time	Sex	S x T
Job stress[b]	Men	420	3.63 (.83)	3.57 (.87)	3.30 (.89)	.001		
	Women	60	3.28 (.82)	3.44 (.90)	3.24 (.97)	n.s.		
	Overall	480	3.59 (.84)	3.56 (.87)	3.30 (.90)	.001	.05	n.s.
Managing demands[c]	Men	409	4.96 (.73)	5.01 (.77)	5.07 (.75)	.01		
	Women	60	4.67 (.83)	4.73 (.87)	4.92 (.68)	.05		
	Overall	469	4.92 (.75)	4.97 (.79)	5.05 (.74)	.001	.01	n.s.

[a] Job stress items were not included on the 1983 lifestyle questionnaire.
[b] Scale ranged from 1 (*None at all*) to 5 (*A great deal*).
[c] Scale ranged from 1 (*Very poorly*) to 6 (*Extremely well*).

Trends in Hypertension and Overall Health

The two remaining variables in this longitudinal assessment are presented in Table VIII. The first variable, a self-report measure of physician-identified hypertension, indicates a significant increase in high blood pressure among men in both cohorts, though not among women. Moreover, the overall percentage of men reporting high blood pressure (a maximum of 18.8% in 1994) was significantly higher than the proportion of women with hypertension (a maximum of 11.5%). Most hypertensive men (89.3%) and all hypertensive women said that their condition was controlled within normal limits. The last variable, self-perceived health rating, did not change significantly over time for any of the groups, nor were there significant sex differences in perceived health.

Replication of Results Across Samples

While it was not the purpose of this study to compare the two cohorts with each other, replication of results across samples would offer confirmation of the reported findings. Therefore, post hoc analyses were conducted for the 20 fitness and lifestyle variables presented in Tables II through VIII (the 10 individuals who were in both samples were dropped from these analyses). The cohorts were compared on their 1994 follow-up scores (means or proportions) using *t*-tests or chi-square analyses.

No significant differences were found on 16 of the 20 measures; observed differences on the 1.5-mile run ($p \leq .01$), sit-ups ($p \leq .05$), breakfast ($p \leq .05$), and smoking variables ($p \leq .05$) all favored the 8-year sample.

TABLE VIII

TRENDS IN HYPERTENSION AND PERCEIVED HEALTH IN TWO U.S. NAVY COHORTS, OVER 8 YEARS (BY SEX) AND 11 YEARS (MEN ONLY)[a]

		8-Year Cohort							11-Year Cohort (men only)			
						$p \leq$						
Variable (Time)	Group	*N*	1986	1989	1994	Time	Sex	S x T	*N*	1983	1994	$p \leq$
High blood pressure[b]	Men	409	12.5	13.9 (1.6)	18.8 (1.7)	.01 (1.9)			88	6.8	18.2 (2.7)	.01 (4.1)
	Women	61	4.9 (2.8)	9.8 (3.8)	11.5 (4.1)	n.s.			—	—	—	
	Overall	470	11.5 (1.5)	13.4 (1.6)	17.9 (1.8)	.01	.01	n.s.	—	—	—	
Health rating[c] n.s.	Men	417	3.82 (.82)	3.79 (.89)	3.76 (.84)	n.s.			228	3.64 (.87)	3.67 (.89)	
	Women	59	3.88 (.77)	3.88 (.87)	3.85 (.83)	n.s.			—	—	—	
	Overall	476	3.82 (.82)	3.81 (.89)	3.77 (.84)	n.s.	n.s.	n.s.	—	—	—	

[a] The 1983 lifestyle questionnaire was administered to shipboard personnel only, which in 1983 did not include women.
[b] Percentage answering "yes" to the question, "Has a doctor ever told you that you have high blood pressure?" (standard error in parentheses).
[c] Mean and standard deviation; self-rating scale ranged from 1 (*Poor*) to 5 (*Excellent*)

Discussion

The main objective of this report was to describe trends in lifestyle behaviors and physical readiness in two longitudinal cohorts of Navy personnel during the decade that the Navy's HAPR Program was implemented. Overall, both cohorts exhibited significant improvements in almost all areas measured over their respective 8- and 11-year time frames. Physical fitness scores on the 1.5-mile run, sit-ups, and push-ups tests were uniformly higher at follow-up; physical exercise (weekly kcal expenditure) had increased; overall diet had improved; and hours of sleep had increased significantly in both groups. In addition, smoking rates dropped substantially, alcohol use declined, and perceived job stress decreased. The only significant fitness decrements observed in both samples were in body composition (%BF, BMI, and percent overweight increased) and hypertension rates, which also increased.

Women's scores were significantly better than men's on a number of lifestyle factors. They demonstrated better dietary choices, reported overeating less often, and were less likely to be overweight (per the BMI) than their male counterparts. Women also experienced less job stress, drank less alcohol, and had lower hypertension rates. However, men were more successful than women in managing their work demands. The finding that women experienced less job stress was somewhat unexpected, given the nontraditional work roles associated with military life, particularly aboard ship. Although we know of no studies that directly compare the shipboard work environment with shore-based jobs, it is generally assumed that shipboard assignments are more stressful, if only because of habitability issues[24] and the strains associated with deployment. Yet the integration of women onto ships is fairly recent and incomplete, and men in the present study were much more likely to have served aboard ship and to have experienced long-term deployments than were women. This might help explain the gender differences in reported job stress, but further research in this area is needed.

In terms of physical fitness, the one PRT measure on which women outperformed men was the push-ups test; otherwise, the sexes did not differ in their fitness classification scores. Women are required to perform about half as many push-ups as men to achieve the same classification score. Thus, although women might be particularly motivated to perform well on the push-ups test and might in fact be performing at a relatively higher level than their male peers, the lack of sex differences on the other PRT measures suggests that the observed difference in push-ups classification scores might be partly an artifact of the test's gender-adjusted criteria.

The trend of increasing body weight, measured here in terms of %BF and BMI, is typical of people as they grow older; it also reflects an increasing trend in the prevalence of overweightness in the nation at large.[25,26] However, at least some of the observed increase in %BF is the result of underestimated baseline %BF values produced by the 1983 and 1986 prediction equations. Post hoc analyses on a subset of respondents for whom all anthropometric measurements were available (as opposed to the reported %BF value only) indicated that the degree of underestimation was about 1% for men. Comparisons could not be computed for women because the circumference sites themselves differed between the 1983/86 and the 1989/94 equations, but the amount of bias in the women's 1983/86 equation was somewhat greater than the men's.[13,14] This being the case, the baseline (1983 and 1986) mean %BF values reported in Table II would be about 1 to 1.5% higher, which would reduce the amount of fat gained over the years by a comparable amount.

The most likely reasons for true weight gain are a sedentary lifestyle and/or a fatty diet. Yet the participants in this study maintained or increased their amount of exercise activity over the years, with kcal expenditures roughly the equivalent of running 20 minutes every day at a 9-minute-mile pace,[11] and their diet scores indicated a reduction in fat consumption. An imbalance between caloric intake and expenditure would, nevertheless, produce weight gain, even among physically active individuals. Total dietary intake was not measured in the study, but the men in the 8-year cohort reported overeating more often (between 1989 and 1994), and there was a significant increase in eating breakfast (frequently a high-calorie meal) among both men and women in the sample. These

eating patterns were not replicated in the 11-year sample, however, even though that cohort exhibited the same trends in body composition.

If we examine trends over the three data points in the 8-year cohort, some clarifying relationships emerge. We see a moderate increase in BMI, occurring primarily between 1989 and 1994, which results in a very large increase—also since 1989—in the percentage of individuals who are categorized as overweight (i.e., exceeding BMI standards). On the other hand, the modest rise in %BF is distributed evenly across the three time periods, and it fails to result in a significant increase in the percentage of members classified as overfat (i.e., exceeding Navy body fat standards). These somewhat disparate patterns suggest that the observed trend in overweightness is not due primarily to greater fatness. Note that LBM, like the percentage overweight, exhibits a substantial jump between 1989 and 1994. Muscle tissue is heavier than fat, and an increase in LBM can produce weight gain even in the absence of an accompanying rise in body fat. It is true that these participants gained fat as well as lean mass. However, the fact that they also were (1) maintaining a vigorous level of physical activity, (2) eating a significantly more healthful diet, (3) exhibiting markedly greater muscle mass, (4) sustaining body fat increases that remained within the Navy's established %BF limits, and (5) demonstrating significantly improved physical fitness scores—despite being 8 to 11 years older—strongly suggests that the sharp rise in "overweight" personnel in this sample should not be construed as necessarily problematic. Steven Blair, Director of Research for The Cooper Institute for Aerobics Research, has commented that in terms of morbidity and mortality, an individual's fitness level is far more important than his or her body weight.[27] This is especially true if a person's weight reflects a high proportion of lean mass relative to fat.

The respondents in this study are not representative of the total Navy, primarily because of their age and educational level. Moreover, because Navy policy prescribes administrative sanctions, including involuntary separation from service, for members who are unable to meet physical fitness and body composition standards,[15] many unfit participants from the earlier HAPR studies had presumably left the Navy by the time this follow-up sample was surveyed. Finally, the original 1986 and 1989 samples were not completely random, due to the sampling-with-replacement methodology used. However, as members of earlier Navywide cross-sectional samples who have remained on active duty for a number of years, these longitudinal participants represent the "career" naval force, whose somewhat older, higher-ranked, service-committed personnel exemplify a new level of physical readiness and serve as models for more junior members of the fleet. Replication of results across the two cohorts further supports the generalizability of the findings to career Navy men and women, whose lives have been subject to influence by the Navy's health promotion efforts for more than a decade. Results of this study suggest that those efforts have had a significant positive impact on the fitness and health behaviors of these Navy personnel.

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This study examines long-term health and physical readiness trends in the U.S. Navy. Lifestyle questionnaires were mailed to all participants from baseline studies between 1983 and 1989 who were still on active duty in 1994. Commands provided body composition and Physical Readiness Test (PRT) scores for the participants. Two longitudinal cohorts were created: an 8-year sample (N = 640) with matched data from 1986, 1989, and 1994; and an 11-year sample (N = 1,576), with data from 1983 and 1994. Analyses of both cohorts revealed significant improvements in physical fitness, exercise, lean body mass, dietary habits, and sleep, as well as significant decreases in tobacco and alcohol use and job stress. However, hypertension rates, percent body fat, and body mass index showed significant increases over time. Women's scores were significantly better than men's on a number of factors. Overall, these findings suggest that the Navy's health promotion efforts have had a significant positive impact on the health and fitness of career Navy personnel.

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