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 Ergonomics/  
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**Workshop Proceedings**

**Health and Job-Specific Body Composition  
 Standards for the U.S. Air Force**

Prepared for: Force Enhancement Department  
 USAF School of Aerospace Medicine  
 311<sup>th</sup> Human Systems Wing  
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**HEALTH AND JOB-SPECIFIC BODY COMPOSITION STANDARDS  
WORKSHOP**

**US AIR FORCE SCHOOL OF AEROSPACE MEDICINE**

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AUGUST 24, 1999 DAYTON, OHIO

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This Proceedings document summarizes discussions that took place during the Health and Job-Specific Body Composition Workshop, sponsored by the USAF School of Aerospace Medicine and supported by the Crew System Ergonomics Information Analysis Center (CSERIAC). The workshop was held at the David H. Ponitz Sinclair Center at Sinclair Community College in downtown Dayton, Ohio on August 24, 1999.

The purpose of the meeting was to achieve consensus among a group of subject-matter experts on the practicality and applicability of using body composition measurements to predict job performance within the US Air Force. Dr. Stefan Constable, Chief, Performance Enhancement Division, Force Enhancement Department, USAF School of Aerospace Medicine, gave opening remarks and conducted the workshop. A presentation covering the CSERIAC *Review & Analysis* entitled *Health and Job-Specific Body Composition Standards for the US Air Force* was given by Ms. Barbara Palmer of the CSERIAC Program Office. The remainder of the meeting was a group discussion coordinated by Dr. Constable. The main points of discussion and consensus are documented here.

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## DOCUMENT BACKGROUND

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CSERIAC has supported several projects for the US Air Force School of Aerospace Medicine by providing a scientific base and related analyses for policy and decision-making. CSERIAC generates a scientific review of relevant literature, and submits this draft to subject-matter experts who are invited to read and critique the document. Reviewers typically submit written comments and attend a workshop where the crucial issues are presented.

This publication contains comments of occupational health and physical fitness subject-matter experts which were submitted after their reading of the CSERIAC *Review & Analysis* entitled, *Health and Job-Specific Body Composition Standards for the US Air Force*, and also documents their input during the August 24, 1999 workshop. The goal of the workshop was to seek opinions, potential approaches, and ultimately a consensus on topics relevant to the Air Force's consideration of health and job-specific standards as they apply to the Air Force's two-tier approach to physical fitness.

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## DOCUMENT OUTLINE

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### ***The Review & Analysis--Reviewers' Written Comments***

- **Selected comments submitted prior to the workshop**

### ***Workshop Proceedings***

- **Workshop discussion among subject-matter experts, facilitated by Dr. Constable, on these topics:**
  - **Air Force Fitness Program Tier I: Health and Wellness Standards**
  - **Air Force Fitness Program Tier II: Job-Specific/Performance Based Testing**
    - **Fat Free Mass as a Screening Tool**
    - **Establishing Fat-Free mass Levels Corresponding to Air Force Specialty Codes**
- ***Additional Issues***
- ***Workshop Suggestions***

## **The Review & Analysis--Reviewers' Written Comments**

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### **SELECTED COMMENTS SUBMITTED PRIOR TO THE WORKSHOP**

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Several questions were posed to the subject-matter experts who read the *Review & Analysis*, most of whom also attended the subsequent workshop. Here are the questions and selected responses.

1. Do you think the Air Force would receive considerable benefit from adding a job-specific body composition component to its physical standards?

***Dr. James Wilmore***

I do not feel that there would be a clear benefit from adding a job-specific body composition component to the USAF physical standards. In my opinion, this Review and Analysis document argues against doing this. Let me explain. You spend a great deal of time making the point that fat-free mass is possibly the best predictor of lift task performance (see Recommendation on p. 28 of *R&A*). This makes logical sense and is supported by good research. However, why work with fat free mass? You make a good case for this relationship between fat free mass and lift task performance being the result of the relationship between fat free mass and functional strength. If this is in fact the case, why not just measure functional strength? You can measure functional strength much more accurately than fat free mass (greater reproducibility) and it intuitively makes much more sense to the person being tested and to those trying to defend it in court. You can even make your strength tests task specific.

I really like the concept of Tier I and Tier II standards. This is a very important concept that should be adopted across all of the services.

I am not convinced that circumferences are the best for estimating body composition. I am not familiar with any study that demonstrates the accuracy of circumference prediction equations to track changes in body composition with diet and/or exercise intervention (weight/fat loss). This is a very important consideration that must be discussed.

It would seem to me that BMI would be a much better first screen than height/weight charts. While BMI is not a perfect surrogate measure of body composition, it comes much closer than standard weight, or to the uses of the height/weight chart.

***LCDR Kathleen Kujawa***

The addition of job-specific physical standards would most likely benefit the Air Force through the reduction of injuries and subsequent costs associated with medical treatment and lost work time. There may be morale benefits within specific jobs as well, since each person would be fully qualified to perform all aspects of the job and would be able to shoulder his/her "fair share" of the workload.

***Dr. James Hodgdon***

Possible benefits are (1) the establishment of a single standard, irrespective of age and gender, for each job category, a standard which is fair because it is related to the job, and (2) the reduction of on-the-job injuries as a result of maintaining adequate physical fitness to carry out jobs safely.

***Ms. Marilyn Sharp***

If adoption of this concept worked with adequate sensitivity and specificity, it would likely reduce work related injuries and increase productivity in the most physically demanding jobs. The need to work around individuals who are unable to perform all their job tasks would be reduced. Determination of fat-free mass can be accomplished safely at a low cost, particularly when compared to strength testing.

2. What do you see as the drawbacks or costs to the Air Force of adding a job-specific body composition component to its physical standards?

***Dr. James Wilmore***

If strength is the real determinant that you want to use to establish standards for lift task performance, then measure strength, and not its surrogate measure (fat free mass). I personally feel that you will have a very difficult time breaking down jobs by body composition status. The error of estimate for body composition assessment is high and the data you have presented would predict that the fatter people would be more desirable for those jobs requiring more strength. This is a paradox that I don't think that you want to get into.

***LCDR Kathleen Kujawa***

There are several hurdles that would need to be crossed before job-specific standards could be put into place—

- definitions of minimally acceptable performance for each specific job
- identification of body composition standards that correspond to minimally acceptable performance
- accuracy of measurement of body composition
- how to deal with individuals who can physically perform a given job at superior levels but whose body composition may not meet the standard

***Dr. James Hodgdon***

Possible drawbacks are the need to maintain and manage different standards for different job categories, and the need for increased physical fitness testing, compared to today's levels.

***Ms. Marilyn Sharp***

I am concerned that the fat-free mass requirement might actually become a predictor of gender. In other words, due to the level of fat-free mass "required" to perform a job, most women would be disqualified and most men would be qualified.

I would prefer to see the relationship between fat-free mass and the job task developed *directly*, rather than using fat-free mass to predict ILM which in turn was used to predict job performance.

In a time when recruiting goals are not being met (at least in the Army), it is difficult to justify another requirement. I don't think body composition really matters to job performance except in the most physically demanding jobs.

### 3. What specific points do you think should be addressed at the workshop?

***Dr. James Hodgdon***

There should be some discussion about whether or not the relationship offers sufficient precision to use as the basis for standards, and/or how fat free mass can be used appropriately as a screening tool. Additionally, there should be some discussion about what is needed to carry out the task analyses to develop job-related standards.

***Dr. James Schlub***

What are the specific reasons for looking at body fat over and above tests of fitness? What is the weight of different criteria in developing fitness tests for the USAF – safety, accuracy, specificity, sensitivity, ease of administration, time involved for testing, cost, job relevance, appearance etc. If one criteria is historically weighted much more than others and that will never change, we need to know that and not converse in a vacuum. Unfortunately, if the main drivers are safety, ease of use, and utilizing health based standards (so more people pass and less people are forced out and more folks enter into the USAF with questionable fitness) versus more stringent fitness-based standards and tests, our task may be somewhat futile. We are constantly barraged by the goal of increased readiness with the smaller armed forces. If readiness is job one – then physical readiness should be numero uno. We are not just talking heads going to war. We don't scrimp on the most high tech gadget for our military machines and we should not scrimp for the people who run them.

***Ms. Marilyn Sharp***

Is this exercise really necessary? How important is this to the AF? What percentage of AFSCs have tasks that are physically demanding? What percentage of the corpsmen are physically incapable of performing the physically demanding aspects of their jobs? I'm raising these questions, although I don't expect anyone has the answers. What are the advantages of using a fat-free mass predictor of performance over the current ILM system?

***LCDR Kathleen Kujawa***

Are anthropometric body composition estimation equations sensitive enough to make job-specific body composition standards feasible? There is not much doubt that, within reason, lower percent body fat and greater fat free mass translate to better performance. However, it is not clear how low body fat or how high fat free mass should be for "optimal" performance on any task. How can these levels be identified? How should minimally acceptable standards for given jobs be defined and identified? Should the emphasis be on physical fitness level, not on body composition? If individuals are able to meet the physical requirements of a job would they also have a body composition compatible with the job requirements?

## Workshop Proceedings

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### AIR FORCE FITNESS PROGRAM TIER I: HEALTH AND WELLNESS STANDARDS

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#### *Consensus*

- The group's consensus was that all services should implement and apply the same or similar general health-based standards.
- Subject matter experts suggested using an age-independent test of body mass index for general health and fitness for all services (see Table 1).
- The application of BMI testing would identify more borderline individuals than current height/weight testing.
- A remedial period would be provided to allow those borderline individuals an opportunity to rectify problems.
- Length of the remediation interval would be at the discretion of the individual services.
- The health-based fitness level would be considered the minimum job-specific requirement.

#### *Points of Discussion*

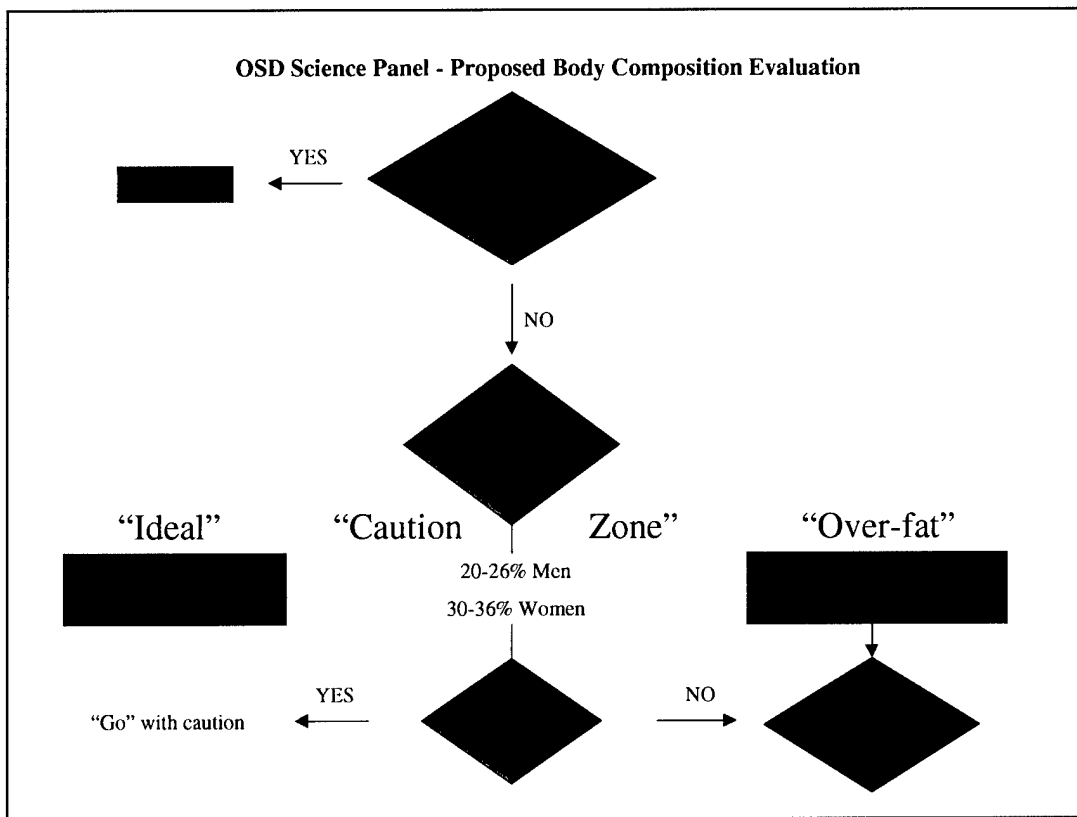
**Maj Baumgartner** outlined some of the necessary steps to employ the BMI approach (Table 1):

- Individuals with BMI under 19 should be referred for medical/nutritional check/counseling.
- The current Air Force height/weight ranges should be compared to the "healthy" BMI levels of 19-25(27). Further evaluation would be needed to establish male and female BMI screening levels.
- Waist girth of greater than 40 inches for men and 35 inches for women could easily be employed as an additional health screen for those individuals in the overfat category (Table 1). Research indicates that abdominal adipose tissue accumulation is a significant correlate of premature development of systemic diseases. Dr. Friedl supported this, stating that abdominal girth and percent body fat are related enough to be interchangeable, if necessary.

**LTC Friedl** suggested that there be a goal of 25 BMI at accession to help prevent current problems of soldiers who enter the services on the upper edge and spend their careers trying to lose weight. He also stated that the upper limit for male BMI should be increased from 25 to 27, since no health deficits have been shown at or below 27 BMI. However, he also noted that most services would not be willing to change their body fat equations or to use new methods.

**Dr. Chumlea** noted that a Tri-Service Mission statement is needed if we are to pursue the use of BMI as a basis for health-based standards. This would be especially important if the standards are to be instituted across all the armed services.

**LCDR Kujawa and Dr. Guo** support the use of an established BMI standard similar to Table 1 to be administered across all of the services.



**Table 1: Proposed Body Composition Evaluation Table (IOM, 1998)**

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## AIR FORCE FITNESS PROGRAM TIER II: JOB-SPECIFIC/PERFORMANCE BASED TESTING

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### *Fat Free Mass as a Screening Tool*

#### *Consensus*

- It was agreed that fat-free mass would be best used as a general screening tool to determine candidates most likely to be successful in physically demanding AFSCs. Ideally, there would be a minimum cutpoint number for these physically demanding occupations.
- While all personnel would be held to a specific health requirement, only those who choose certain AFSCs would be further tested.
- The group also agreed for the most part that, while not perfect, fat free mass (fat-free mass) is the best candidate for use as a safe screening tool for physically demanding Air Force Specialty Codes (AFSCs). It does not carry the dangers and logistical problems associated with strenuous physical testing.
- Once a person passed the initial fat-free mass screen, a job-specific strength test would then be applied to determine fitness for job-specific tasks. The nature of the strength test has yet to be determined.
- Lastly, the group agreed that taking fat-free mass beyond use as a screening tool would not be justified at this time. To go beyond screening to performance prediction would require a direct strength test.

#### *Points of Discussion*

There was a great deal of discussion regarding the use of fat-free mass, especially regarding the strength of the relationship between fat-free mass and job performance. Members of the panel agreed that further research in this area is essential to the future use of fat-free mass as a valid physical fitness measure versus strength alone.

**Dr. Hodgdon** noted that we might need a more direct test. That is, we are indirectly testing physical strength through body composition, which is an indirect indicator of success at physically demanding AFSCs.

**Maj Baumgartner** spoke in support of the use of minimum fat-free mass, stating that some individuals can be trained up to minimum strength and some can not. This is a good way to prioritize training resources and assign personnel to appropriately demanding AFSCs. He suggested that in selecting personnel we should look at the lowest necessary denominator, that is, the lowest fat-free mass necessary to accomplish the job.

**Dr. Chumlea** stated that fat-free mass would be a good measure to exclude individuals who could not handle strenuous AFSCs as well as flagging/identifying those that may have potential problems with rigorous training. He also cautioned that research on specific segments (using DXA) may be needed to validate the use of fat-free mass. He noted that as fitness increases, quadriceps size decreases; and sometimes as fitness increases, so does strength. In both cases, measured fat-free mass remains the same, even though there is a definite difference.

**LTC Friedl** noted that there should still be some body fat measure as there are some duties for which some soldiers can simply be too large, with respect to crew space requirements (tanks, aircraft, etc.) He pointed out, however, that sometimes the strongest soldiers are the fattest. He then cautioned that modern warfare consists of city fighting, which requires more speed and endurance than strength. He also posed the question, "What if the health goal is higher than the performance goal?"

**Dr. Constable** suggested that, for individuals who are overweight but appear to have a good level of physical fitness and can pass fitness tests, maintaining an adequate exercise routine would be an important criterion. Documentation of fitness may be grounds for a waiver of sorts.

**Dr. Guo** questioned the use of existing prediction equations to measure fat-free mass, suggesting bioelectric impedance analysis of body fat as an alternative. She proposed further study with respect to fat-free mass. For instance, what is the lean body mass of individuals who do pass the fitness tests? She raised some sensitivity and specificity issues as well. In the end, she questioned the need for this effort at all, questioning the number of people who actually need to be tested for how many jobs.

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## AIR FORCE FITNESS PROGRAM TIER II: JOB-SPECIFIC/PERFORMANCE BASED TESTING

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### *Establishing Fat-Free Mass Levels Corresponding to Air Force Specialty Codes*

#### *Consensus*

- While job-task analysis is a well-defined methodology, no consensus was reached on a comprehensive process to establish fat-free mass levels for Air Force Specialty Codes.
- The first step to establish specific levels would be to establish categories of job demands in a consistent manner within the Tri-Service community.
- Additional research is needed to establish the level of fat-free mass necessary for success or as screening tool for each particular job.
- It would be desirable to establish sensitivity and specificity measures for proposed fat-free mass cut-points.

#### *Points of Discussion*

There was a discussion on Army research in this area. The Army generated a large database of the physical demands of Military Occupational Specialties. In practice, soldiers generally found alternative ways to do the job. Attempts to match tests to job requirements that lacked scientific rigor were discussed, including the Air Force's Fighter Aircrew Test (FACT).

**Maj Baumgartner** suggested that we use existing job analyses to perform a task analysis; a fat-free mass value that corresponds meaningfully with job performance can then be established.

**Dr. Chumlea** suggested that we gather more data regarding physical tasks: male versus female; the types of individuals who can/can not pass physical tests; and a study of the general population to see what is available in the recruitment pool.

**Dr. Constable** noted that in the combat arena, as is other arenas, certain non-negotiable standards for physically challenging jobs are needed. That is, the demands of the job are not in many circumstances modifiable, and in these cases, the human who performs the work must meet certain criteria.

**LTC Friedl** summed up why the Army failed to define specific strength requirements for specific jobs: Job requirements were not always tied to strength and there was no link between the arbitrary tests and task performance. Polls of individuals who performed the tasks yielded little usable data as there was no standard rating scale and scores for the same job ranged widely, depending on the person doing the rating.

He also stated that the thresholds between tasks can be fuzzy and can essentially depend on the selectivity of the service. For instance, the Air Force generally has fewer physically demanding tasks than the Army and might therefore funnel the stronger soldiers to those jobs.

**Dr. Guo** suggested that we examine the physically demanding jobs in question, and divide them into less specific quartiles.

**Dr. Hodgdon** suggested that rather than doing extensive interviewing and task analyses, we simply establish a criterion for performance as a cut-point. The cut-off would be whether an individual could get the job done.

**LCDR Kujawa** questioned whether we even had the data regarding the exact level of fat-free mass for each particular job.

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## ADDITIONAL ISSUES

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### *Points Covered*

This section captures comments made during various sessions of the workshop. The recurring suggestion made by the attending experts was that there is a need for more data. Specifically, there is an overwhelming need for a central database that has specific information on injury rates, body composition, fitness, and job specialties. The acquired information could then be used to pave the way to answering many of the questions raised at this workshop.

**Maj Baumgartner** noted that if a strength test is necessary, it should be a machine-based test. It would be significantly more reliable and consistent than calisthenic tests.

**Dr. Chumlea** suggested that we use OSHA data to support and supplement the military database on injuries.

**Dr. Chumlea, Maj Baumgartner, and LTC Friedl** all agree that the existing body fat prediction equations are not accurate enough, but concede that none of the services is likely to change those equations.

**Dr. Constable** acknowledged that the best pragmatic way to establish job-specific fat-free mass values is to leverage the resources of all the services and perhaps even some NATO countries. He also noted that the best predictor of performance is content-based testing (vs. criterion or construct-based testing).

**LTC Friedl** strongly supports performance-based testing (or content-based testing), stating that we may be getting further away from the goal of testing performance when we use strength tests or fat-free mass. For instance, rather than giving strength tests to soldiers manning a howitzer, he recommends a 24 hour stress operations test which would consist of loading and firing the weapon consistently. He also suggested that once we collect the data on minimum levels needed to perform jobs, we can then determine needed levels of occupational fitness without using criterion-related standards.

**Dr. Guo** commented that there are no existing studies on the body composition of individuals who are successful at physically demanding jobs.

**Dr. Hodgdon** mentioned that there is a Navy injury database that could be used to relate specific jobs with injuries. He also noted that when predicting an individual's job performance, the first variable is may be his/her weight, while the second may be his/her attitude. Perhaps motivation needs to be addressed as well.

Regarding the lack of database information on individuals who cannot perform their duties, **LCDR Kujawa** remarked that many soldiers do not complain about an inability to do the job, but simply find someone to help or another way of completing the task. This may be the reason we have little information on personnel who cannot complete assigned duties.

**Ms. Palmer** noted that given the complexion of modern warfare we may need to look more at running tasks and endurance as opposed to strength.

**Dr. Schlub** mentioned that we might need to look at more than just fat free mass. He suggests additional performance testing. He also suggested a scatter-plot comparison of body composition across all services to see where we are.

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## WORKSHOP SUMMARY

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### *Specific Suggestions*

As a minimum, BMI should be used as an age-independent measurement of body composition health screening across all services. Remedial actions would be determined by the individual services.

Fat free mass is the best candidate for a safer and simpler performance predictor of muscular strength.

Fat free mass could be used as a screening tool for those individuals who want to participate in physically challenging Air Force Specialty Codes. It is also a logistically convenient measure.

### *General Suggestions*

Determining exact levels of performance and corresponding fitness levels (i.e., strength, fat-free mass/body composition) necessary for specific jobs requires much more scrutiny and will likely incorporate a direct measure of strength.

More data is needed in several areas, including injury report databases for civilian and military populations if body composition is to be considered further.

Fat-free mass should only be considered as a limited surrogate for measures of strength.