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REPORT NO T15-90

ASSESSMENT OF BODY WEIGHT STANDARDS IN MALE AND FEMALE ARMY RECRUITS

U S ARMY RESEARCH INSTITUTE
OF
ENVIRONMENTAL MEDICINE
Natick, Massachusetts

UNITED STATES ARMY
MEDICAL RESEARCH & DEVELOPMENT COMMAND

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ASSESSMENT OF BODY WEIGHT STANDARDS IN MALE AND FEMALE ARMY RECRUITS

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December 1989

DISCLAIMERS

The views, opinions, and findings contained in this report are those of the authors and should not be construed as official Department of the Army position, policy, or decision, unless so designated by other official documentation.

Human subjects participated in this study after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on "Use of Volunteers in Research."

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Army enlisted candidates are screened for obesity with height-weight tables (AR 40-501) which exclude few young males but approximately one third of young females in the U.S. population. Another regulation (AR 600-9) sets standards for retention in the Army on the basis of body fat estimated from circumferences. The effects of these two disparate sets of standards were studied in a sample of 1894 recruits starting basic training at Fort Jackson in Fall 1988, concluding with a survey conducted through their company commanders 6 months after basic training. The suitability of accession weight standards with respect to the retention standards was examined by studying the effect of excess fatness on attrition from active duty, physical performance, and ability to achieve fat standards after basic training. The data suggest that accession standards should be based on body fat, the gap between the two male standards should be reduced, further study is necessary to determine if females could be granted a similar allowance, and female body fat (retention) standards should be liberalized (still keeping within the objectives of the Army Weight Control Program).

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Weight is not a regulated quality in any code of laws governing the enlistment of recruits. The circumference of chest thought to be indispensible as an accompaniment to certain degrees of stature, is carefully laid down in the English regulations, but weight is not even mentioned. It is presumed that the matter is left to the discretion of the examining surgeon, with whom the decision as to the other qualities named might, it is thought, be also left with advantage. A due proportion in the weight is quite as essential in the soldier as a well-formed chest, and is of greater importance than lofty stature.

Colonel Jedidiah H. Baxter (1875),
Chief Medical Officer of the U.S.
Provost-Marshal-General's Bureau

That a member whose weight exceeds the maximum for his or her height will not be utilized as the sole criterion for a classification as obese. Conversely, a member whose weight does not exceed the maximum may, in fact, be obese. Evaluation of the body build, muscular development, and bone structure may be necessary to differentiate between these conditions. A view of the entire body should be taken, noting the proportions, symmetry of the various parts of the body, chest development, abdominal girth, and the condition and tone of the muscles. An overweight member, who is obviously active, of firm musculature, evidently vigorous and healthy, and who presents a satisfactory military appearance, should not be classified as obese. Obesity will be determined by a physician at the medical treatment facility.

AR 600-9, 30 Nov 76, "The Army Physical Fitness and Weight Control Program"

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

FOREWARD

The U.S. Army currently has two separate and different programs addressing body weight limits. The program for on-the-job soldiers (referred to as the retention standard, AR 600-9) utilizes a two tiered system: an initial body weight-for-height limit, followed by a secondary body fat evaluation applied to those exceeding the weight-for-height limit, with the ultimate standard being body fat. In contrast, the system for new entrants into the Army (referred to as the accession standard, AR 40-501), utilizes only a weight-for-height standard. There is currently no connection between these retention and accession standards. Furthermore, the accession body weight standards are currently set at a level which permits entry of male recruits who are well above retention fat standards, but restrict females to weights which approximate the retention fat standards. These accession standards also exclude nearly one third of young U.S. women from Army service, but exclude few young males.

This study was conducted to explore the relationship between these two standards. Specifically, in response to a request from Office of the Deputy Chief of Staff for Personnel to The Office of the Surgeon General (28 May 1987), we were asked to study the suitability of the accession standards with respect to the retention standards, and to reexamine the basis of the higher rate of exclusion of females from the national population. This was done by examining the relationship of excess fatness, as defined by current retention standards, to attrition, physical performance, and achievable weight and fat loss in male and female recruits.

ACKNOWLEDGMENTS

We are grateful to SPC Wendy (Robison) Weringo for her management of the data file. The successful completion of this report is due in large measure to her outstanding work and dedication.

We are also grateful to Ms. Donna T. Cardinal for turning a computerized listing of unit addresses into a useable mailing list for the survey.

Members of the onsite (Fort Jackson) study team under the direction of LTC Bruce H. Jones included SPC Wendi G. (Robison) Weringo, Ms. Debbie Jezior, SGT Jeffery S. Staab, SPC John Kaszuba, Mr. Robert P. Mello, SPC William S. Scott, SPC Christopher Butkovich, CPT Joseph Knapik, SSG Celso Santiago-Morales, SSG David Moore, SPC Julio Gonzales, and MAJ David Cowan.

COL David Schnakenberg provided proactive support and encouragement of this research in his role as the Institute Commander during the time that most of this data was collected.

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COL Dale Block and LTC Judy Turcotte at Office of the Surgeon General provided valuable discussion of Army Weight Control Program issues.

The results of this study were briefed to MG Russell (USAMRDC, 3 Nov 89), MG Lanoue (OTSG, 7 Nov 89), BG Stroup (ODCSPER, 7 Nov 89), and MG Wheeler (USAREC, 14 Dec 89). Some of their comments and questions have been incorporated into this final report.

SUMMARY

The purpose and methods of Army assessment of body size have changed over time but not all regulations have changed consistently to reflect these altered goals. The original purpose of height-weight tables was to exclude underweight candidates from Army service. Upper limits of weight emerged in the 1960's to exclude overweight candidates and height-weight accessions standards (AR 40-501) are now the sole basis for exclusion of potentially obese men and women. Separate tables for weight control (retention) standards were issued in 1976. By DOD directive, the weight control standards further evolved into a program based on body composition instead of body weight standards. The current retention standards (AR 600-9) are based on percent body fat and use height-weight tables only as an initial screen to determine who is at risk for obesity by established Army standards of percent body fat. Thus, two regulations assess obesity by two different sets of standards and no attempt has been made to link these two standards.

In the past decade, female representation in the Army has substantially increased and standards of body size and body composition have been applied largely on the basis of male standards. Thus, females have been held to height-weight standards which are more stringent than male standards, possibly by the reasoning that this compensates for sex differences in physical performance. The body fat standards have similarly been linked to the male standards by allowing an 8% body fat unit difference to account for the estimated difference in sex specific essential body fat. The effect of these female accession weight standards is to exclude nearly one third of otherwise suitable female candidates from Army service (while few males are excluded). Later female soldiers are held to body fat standards which are more stringent than the male standards. Thus, the Army physical standards appear to discriminate against female soldiers.

In 1985, the Office of the Assistant Secretary of Defense, Force Management and Personnel (OASD(FM&P)) requested that all services review accession height and weight standards, specifically with respect to males and females. As a result, this study was conducted. The key objectives were to:

1) establish the relation between accession height-weight standards and subsequent military performance (physical performance and success in the Army) as a function of gender, 2) determine the appropropriate relationship between accession standards and retention standards, 3) determine if a measure of percent body fat is the appropriate accession standard, as it is for the retention standard, and 4) further evaluate the appropriateness of the current retention standards.

Male and female recruits were studied at Fort Jackson basic training from the time of entry to active duty (EAD) in the Fall of 1988. Height, weight, circumference measurements, and demographic information were collected by a study team at the reception station for 1894 participating recruits. APFT performance, unit recorded weights and heights, and all separation actions were recorded for 2623 recruits in participating units. The soldiers were again surveyed through their unit commanders at their first unit, approximately six months (6m) after the end of basic training. Weight, height, and circumferences were obtained from the units of 75% of the soldiers reached by survey.

The results of this study compared to national survey data suggest that accession weight tables exclude few males who are within fat standards while some young males who exceed even 30% body fat are accepted. In contrast, the female accession weight tables appear to exclude many females who are not overfat by retention standards. Because the female accession standards are stringent, female recruits are tightly grouped around the retention fat standards with nearly one third of new recruits exceeding the fat standards, but the majority of these females only exceed their standards by a few percent body fat units. Black males and females had significantly lower body fat and were less likely to exceed retention fat standards than non-black recruits.

There was little relation between fatness and attrition, with only a slight trend for overfat males to be overrepresented in the attritees. There was a significantly larger proportion of overweight (by retention screening tables), but not overfat, females retained compared to females attrited, possibly reflecting advantages of a larger body size, related to greater muscle mass.

The current fat standards were reasonable markers of APFT performance in males. However, the relationship between female body fat standards and performance was weaker in this sample and the female standards did not clearly correspond to any inflection points in performance.

Fat males and females at all levels of fatness lost weight in basic training. Males continued to change in the same direction following basic training while females tended to gain weight, regaining all weight lost during basic training and gaining additional weight, over their initial weight at EAD. In terms of body fat, there was no decrease in the proportion of overfat females compared between EAD and 6m. Males had more success in fat reduction and the proportion of overfat males significantly decreased by 6m. Males up to 4% body fat units overfat were likely to achieve their standards at 6m. Thus, males and females were both clearly capable of significant weight loss during basic training but only the overfat males maintained this weight loss. The reasons for this gender difference are unknown but may be attributed to motivational differences related to differences in the current standards, differences in the physical demands of assigned specialties, differences in recreational physical activity and other social factors and physiological differences in fat regulation.

The results of this study support a recommendation that accession standards should be based on body fat instead of body weight. Male recruits could be given some allowance (approximately 4% body fat units greater than the retention standards) and be expected to achieve their standards by 6 months after the end of basic training. A change to body fat accession standards with this allowance would have reduced this sample of male recruits by 8.5%, including elimination of the fattest and least physically fit males. Further study is necessary to determine if such an allowance is appropriate for female recruits. Thus, a switch to body fat standards for accession standards would help compliance with the Army Weight Control Program but would also exclude many (31.6%) females who are close to their current standards and who are not measureably less fit or less suited to their military occupational specialties. This suggests that female retention standards need to be reexamined and reset according to some nonarbitrary rationale not linked to male standards.

INTRODUCTION

ORIGINS OF ARMY ENTRY (ACCESSION) WEIGHT STANDARDS

As early as World War I, Army accessions were screened with height-weight tables. These standards were designed to exclude underweight males whose underdevelopment may have marked chronic disease such as tuberculosis, and who were nevertheless considered unsuitable to the physical demands of the Army. The tables gave minimum acceptable weights and "desirable" weights for all soldiers by height. A soldier was considered unfit for military service if general examination proved him to be "*undersized, underweight, undeveloped, pale and emaciated, poorly nourished with thin flabby muscles, or manifestly lacking in stamina and resistance to disease*" (AR 40-105, 29 May 1923). Meanwhile, obese applicants were eliminated only for overt morbidity, or if their weight was excessive for Cavalry service. Thus,

> *Variations in weight above the standard are disqualifying if sufficient to constitute such obesity as to interfere actually or potentially with normal physical activity, as may be evidenced by high blood pressure, a beginning nephritis, breaking down of the arches of the feet, or other defects incident to such condition. (AR 40-105, 29 May 1923)*

This emphasis on the exclusion of underweight soldiers continued through 1960. Men were routinely accepted for duty if their weight was greater than the standards for height "*provided the overweight is not so excessive as to interfere with military training*" (MR 1-9, and later AR 40-115).

Weight tables for female soldiers emerged in WWII, specifically for Army nurses. As with the standards for males, the emphasis was on the exclusion of underweight applicants. The permissible limit below the tabled "average" weight was 15 pounds. Unlike the male tables, these tables were subdivided into age categories (in 5-year intervals) and the weight increased with age. As with the male tables, there were no upper weight limits governing acceptance into the Army but the regulation (AR 40-100) recommended that the weights

given for the age group 26-30 were the ideal ones to maintain.

By 1960, the regulation on "Standards of Medical Fitness" (AR 40-501), listed height-weight tables with both minimum weights and age-related maximum weights for men and women (Appendix Table A). No longer were candidates to be evaluated for obesity if they exceeded weight tables; large men and women were excluded absolutely. These stricter standards reflect the difference between the wartime demand for soldiers and a peacetime Army able to apply more arbitrary physical selection criteria.*

In 1983, the maximum allowable weights of the 1960 regulation were further modified, with increased weight allowances for taller men and women and decreases for shorter men and women (Appendix Table B). (Commissioned officers are held to the standards of AR 600-9). The basis of either of these accession tables is uncertain. They do not correspond to any of the major actuarial tables such as the height-weight tables of the Metropolitan Life Insurance Company, or with previously published recommendations from Army agencies such as the Office of the Surgeon General (1) or Quartermaster anthropologists (2), which were based on actual soldier data, nor do they correspond to the earlier standards used. As further example of the arbitrary nature of these tables and their periodic changes, two of the 5-year age intervals were collapsed to 21-30 years for males, but not for females. These standards have not been changed further during the time in which a separate set of "retention" standards, based on body fat measurement, have been developed and refined for all active duty soldiers.

A recent proposal to change the accessions tables to a different arbitrary standard which would be more equitable between sexes (in terms of proportions excluded) was rejected by the Army. In 1985, a detailed study by the Defense Manpower Data Center noted that males and females were not equally treated by the accession standards of any of the services. These standards excluded 32.2% of young women in a nationally representative

* In the current regulation these weight tables pertain only to the volunteer Army; standards for mobilization do not include height or weight restrictions.

sample, the second cycle of the National Health and Nutrition Examination Survey (NHANESII). In the same sample, only 4.7% of males would be excluded from enlistment by their weight. The proposed solution was to establish new tables which allow entry of both men and women at weights up to 120% of their respective national averages (3).* The proposed standards would change the percent of excluded U.S. males and females to 8.3% and 12.8%, respectively. A followup report (5) further suggested that these were appropriate standards for males since first enlistment attrition rates were higher for males above these relative weights. For females, there were no discernably higher attrition risk categories, although few females greater than 120% of the national average weights were available for study because of the existing exclusionary standards. This recommended change was a simple and logical proposal, except that it did not take into account the Department of Defense (DOD) directed move to standards based on body fat assessment.

EVOLUTION OF AN ARMY (RETENTION) WEIGHT CONTROL PROGRAM

In response to perceived problems in an increasingly sedentary Army, weight control regulations for active duty soldiers were revitalized in 1976. A new set of weight standards, unrelated to the tables in AR 40-501, were generated under the personal direction of General Bernard W. Rogers.** All active duty personnel were required to remain below the maximum allowable weights (Appendix Table C), regardless of age, or be assessed by a physician for obesity. If they were judged to be obese, soldiers were to be placed on a prescribed diet and exercise regimen. Now commanders were permitted to apply adverse administrative actions for unsatisfactory progress in weight loss,

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* This is essentially the same definition of overweight used by the Surgeon General of the Public Health Service: *"People are considered overweight if their body mass index exceeds the 85th percentile for young American adults (approximately 120 percent of desirable weight)"*(4). This corresponds to BMI > 27.8 for males and > 27.3 kg/m^2 for females, based on the NHANESII data.

** The previous weight control regulation (AR 632-1, Apr 1972) was combined with a physical fitness regulation (AR 600-9, Jan 1965) and the new weight tables were added. The male upper limits were 125% of the "desirable" weights in the WWII standards. These, in turn, were from the original 1912 medico-actuarial tables based on mean values of the insured population at age 20 (6). These standards are still with us, as male screening weights for age 40 & over, in AR 600-9.

if they found it to be "*indicative of apathy, a lack of self-discipline, evasive performance, or other character deficiencies.*"

The stated objectives of this program were to: "a) maintain the weight of all personnel at a level which is best suited to permit them to perform theirduties in a peacetime or combat environment, and b) present a smart soldierly appearance expected of a combat ready Army." Military appearance was the mainspring of this regulation, as detailed in a singular paragraph:

> *The wearing of the Army uniform should be a matter of personal pride and satisfaction. Each soldier is a representative of the United States Government, and should have a physical configuration and posture when in uniform that is trim and smart. Waistlines that stretch the front of an otherwise well-fitting blouse or shirt, and "pot-bellies" detract from good military appearance.* (AR 600-9, 26 Nov 76)

Although it applied to both sexes, this regulation was clearly designed with males in mind. No special mention was made of excess fat distributed in female-specific patterns (e.g. standards of military appearance for bustlines).

A major revision of this regulation in 1983 removed the subjective physician's assessment of obesity by adding direct estimation of body fat and setting age- and sex-related body fat standards. This conversion to the measurement of body fat was specifically directed by DOD. Although they are related within a population, body fat and body weight (for height) are distinct qualities (see Figure 1). Unlike the accession standards, this allowed soldiers of above average musculature to be retained without adverse actions. It also objectively quantified an individual's fatness for an aggressive enforcement of body composition standards, instead of relying on a commander's assessment of a soldier's appearance and ability to perform his/her duties.

DOD directive 1308.1 suggested an eventual goal of 20% and 26% body fat for all male and female military personnel. However, for the Army retention standards, the most stringent limits were set at 20% and 28% for the youngest

age category of men and women. This standard of 20% body fat for young males was based partly on soldier data relating aerobic capacity and body fat (7). It was also recommended as a reasonable upper limit which allows a 5% body fat interval over the average fatness of fit young males (8). Rather than accepting a similar 5% interval over the average fatness of fit young females, the female standards were established relative to the male standards. Thus, the 8% gap between Army male and female standards denotes a sex-specific "essential body fat" difference which is commonly estimated at 8-10% body fat units (9) although even larger differences are observed between males and female mean values in some studies. The DOD suggested upper limit of 26% body fat was considered too restrictive for young females since mean fatness of female recruits was 28% at the time that the standards were established (10,11). (For comparison, male recruits averaged 16%). Arbitrary allowances were also made for age to reflect established but poorly quantified maturational changes in body fat (Table 1).

Table 1. Army body fat retention standards.

Age range	Males	Females
17-20	20%	28%
21-27	22	30
28-39	24	32
40 & over	26	34

from: AR 600-9, 15 April 1983

Initially, body fat was assessed by the Durnin-Womersley equations using skinfold thicknesses measured at four body sites (12). This was chosen as the interim method (13), while body fat prediction equations based on a U.S. Army sample were being developed.* This method was selected on the basis of its

* This was used only as an interim method because of several drawbacks. Skinfold measurement cannot be reliably used by untrained observers, thus, obesity assessments were left in the hands of specialized medical personnel who had to be trained and monitored. The equations applied to age intervals which produced distressingly large increments in the estimated body fat for a given sum of skinfold thicknesses at certain birthdays. A third problem was that the method was developed on a population of primarily middle-aged northern Scottish men and women, perhaps reducing the suitability to the U.S. Army population.

historical use in military populations and its field expediency, compared to other available methods.

The regulation (AR 600-9) was again revised in 1986 to specify a new procedure for body fat measurement. This method was based on a new set of predictive equations developed expressly for the regulation from an active duty Army sample in the 1984-1985 Army Body Composition Study (14). A key feature of the method is that it can be applied accurately at the unit level by simple measurement of body circumferences (Appendix E). For males, the fat component is assessed by an abdominal circumference and adjusted for fat free body mass by a neck circumference and height. For females, the fat component is assessed by weight and by a hip circumference, with adjustments

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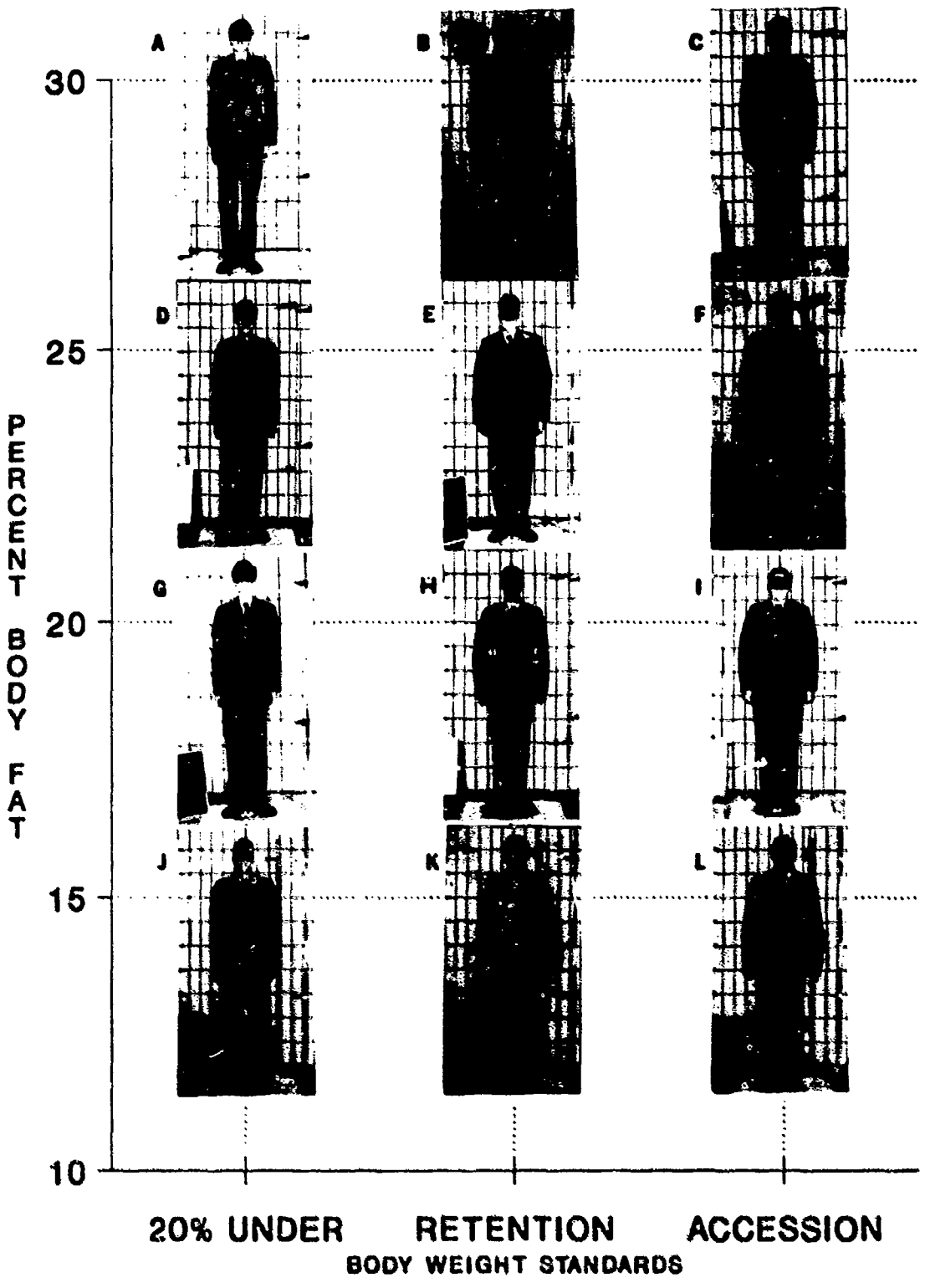
Figure 1 (facing page). The relationship between weight and body fat standards, illustrated in terms of military appearance. For purposes of comparison, these soldiers are matched by characteristics as young, white, male soldiers of similar height (See Appendix D for specific characteristics of these subjects). They are arranged in columns by approximate weights: 145 lbs (20% under retention weights), 170 lbs (approaching retention weight screen limits), and 195 lbs (approaching accession weight limits). They are arranged in rows by approximate percent body fat (measured by underwater weighing). By accession standards, all of these men could enter the Army, but the two soldiers who are overweight and overfat by retention standards (c,f) would be eliminated if they did not lose fat on the Army Weight Control Program. The two overfat soldiers who approach their retention weight limit (b,e) would also be at risk if a commander chose to have them assessed for body fat (a commander's prerogative for a soldier who does not present a good military appearance). The other two low weight but overfat soldiers (a,d) could also be identified by a commander although this is unlikely, particularly if their job performance is satisfactory. Thus, by using a weight screen first, the emphasis of the retention standards is on large fat soldiers and not on the undermuscular fat soldiers. Accession standards exclude only the most obese males. There is no analogous graph for female soldiers since accession and retention weights are similar and the sample of females 20% below retention weights is small.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ACCESSION
BODY WEIGHT STANDARDS

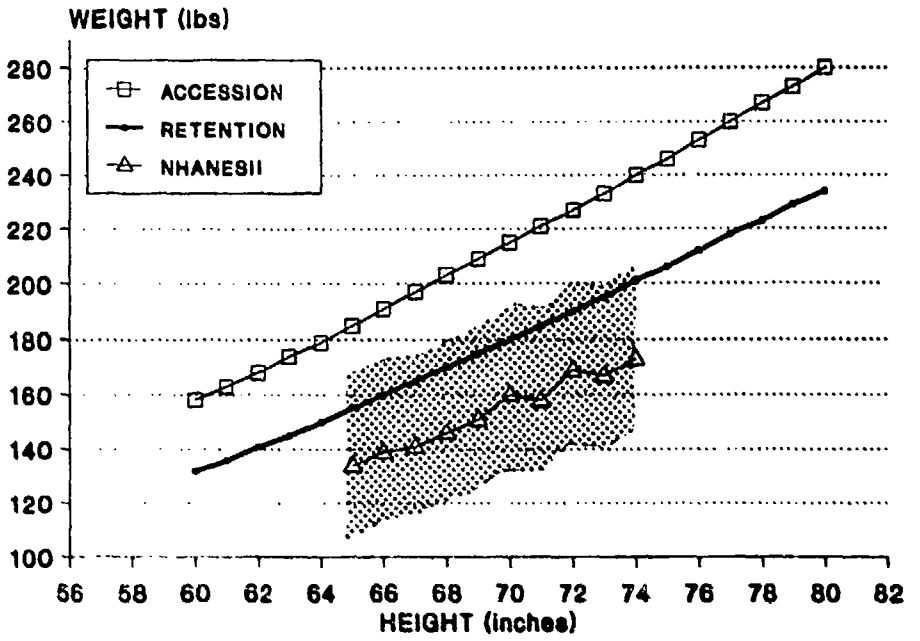
from height, and neck, wrist, and forearm circumferences. This method has the same range of precision (±3-4% body fat units) found in other expedient methods based on underwater weighing, including circumferences, skinfold thickness, other anthropometry based methods, and electrical impedance (14-15). These methods probably cannot be further improved without a significant technological breakthrough (16).

Height-weight tables are retained in AR 600-9 as a screen to determine which soldiers need to be measured for body fat. The use of screening weight tables is a holdover from the earlier method of skinfold measurements, when it would not have been practical to routinely screen all soldiers because the method required trained caliper users, already straining limited resources. The current Army circumference method can be applied routinely at the unit level and by soldiers themselves. However, the continued use of weight tables also provides a margin of safety for the majority of soldiers, recognizing that all indirect methods of body fat measurement are imprecise. Thus, body fat assessment is still reserved only for those soldiers who exceed weight tables.

The screening tables were developed to approximate the relationship between body proportions (height & weight in a specific relationship of wt/ht^2, known as body mass index) and fatness, as related to the specific age- and sex-related fat standards. This was achieved by making the 1976 standards the screening weights for the upper age category (40 years & over) for males and females, and making the body mass index standards more stringent in the younger age categories (Appendix Table F). In fact, these maximum weights from the 1976 regulation formed the basis from which the remaining weights and, by reverse calculation, from which reasonable but arbitrary body fat standards were derived. Following the Army Body Composition Study, the female screening weight table allowances were increased by 5% to better align screening weights to the body fat standards (Appendix Table G).

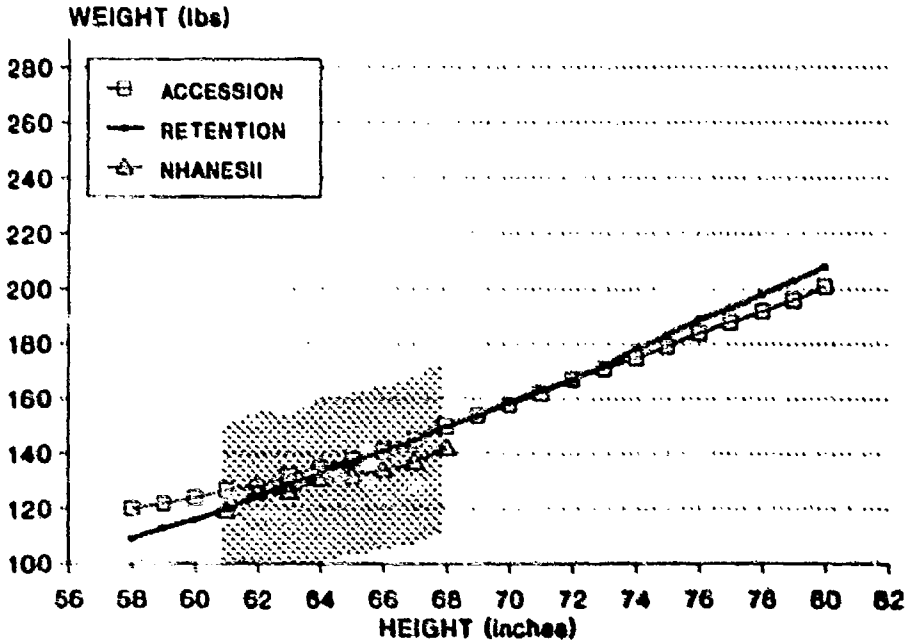
Figure 2 (facing page). Plotted values from current accession and retention weight tables for men and women in the youngest age category (17-20 years). Mean values of the U.S. population (NHANESII) in this age range are shown ±1 standard deviation in the stippled area (68% of sample).

17-20 YEAR OLD MALES



age ranges for male accession standards
and for NHANESII mean values: 18-20

17-20 YEAR OLD FEMALES



age range for accession standards: 18-20
age range for NHANESII mean value: 18-20

COMPARISON OF ACCESSION AND RETENTION STANDARDS

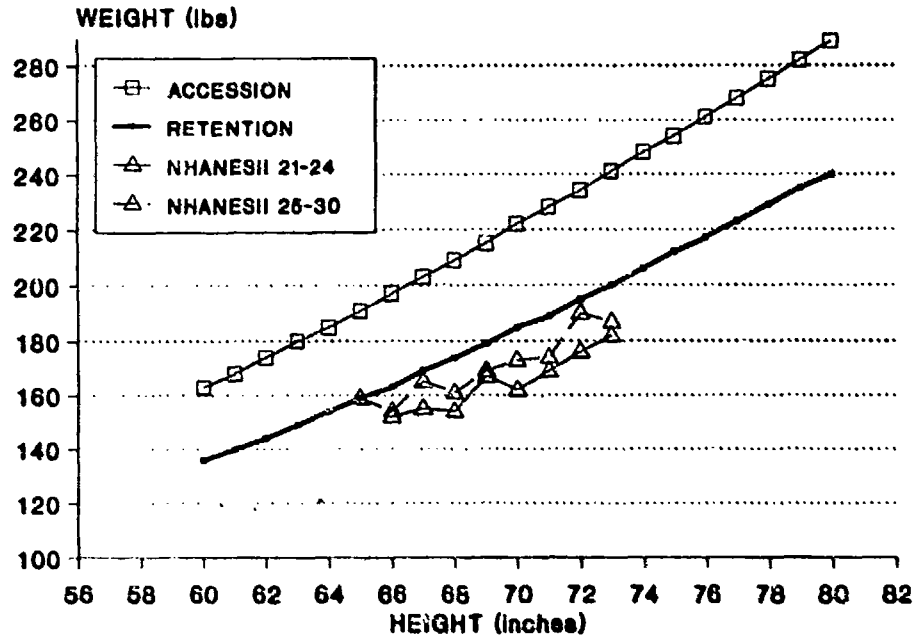
The Army Weight Control Program (retention) regulation has evolved to an assessment of fatness by measurement of body fat, but the regulation governing accessions has not changed from the use of only height-weight tables for the same purpose of identifying overfat candidates. There is no correspondence between the weight tables used in the two regulations and even the age categories are different. Not surprisingly then, the male and female accession weight tables are in arbitrary disagreement with the retention weight screening tables. Their relationship and the relationship to national averages are shown in Figures 2 and 3 for the two youngest age categories of the retention standards (these age ranges represent approximately 95% of new recruits). The same relationships exist for accession weight standards, retention weight screening tables, and mean values from the U.S. population at the two upper age categories.

There is no apparent difference in body mass index of young males and females, based on the NHANESII data for the youngest age category (16-20 years). Both have a BMI of approximately 22.3 kg/m2, corresponding to mean body fats of roughly 15% for males and 27% for females. Only the range of heights differs between the sexes while BMI follows the same continuum.

Retention screening weights reflect the retention body fat standards which they approximate. For men, these are well above the national mean while for women the weight screen is close to the national mean. As illustration of this point, the mean of young male recruits is 16% body fat and they are allowed up to 20 or 22% body fat. The mean of young female recruits is 27% body fat and they are allowed up to 28 or 30% body fat. Thus, the mean fatness of female recruits are nearly superimposed with retention screening weight limits.

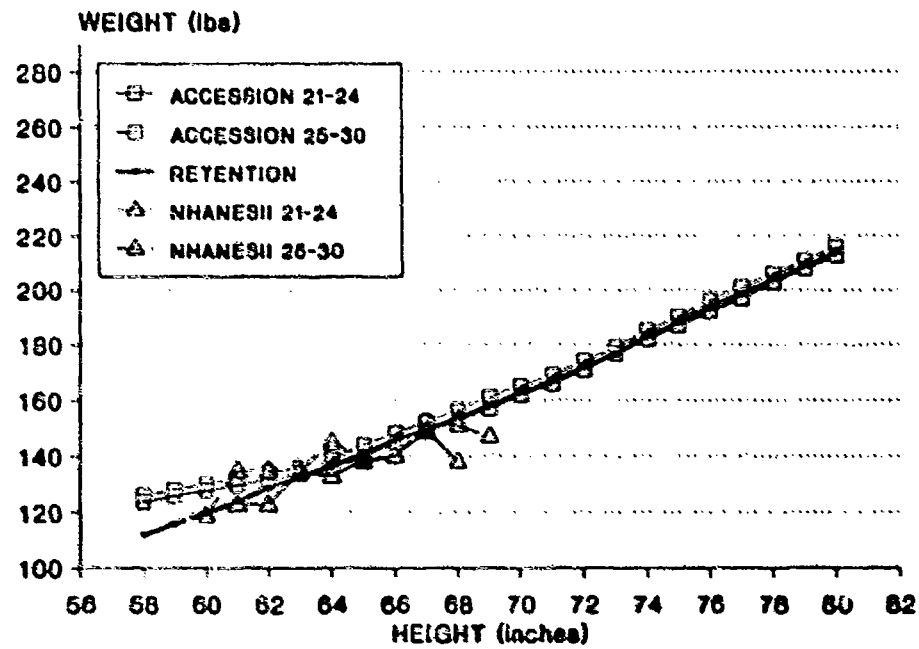
Figure 3 (facing page). Plotted values from current accession and retention weight tables for men and women in the second youngest age category (21-27 years). Mean values from the U.S. population (NHANESII) for age categories in this range are also shown.

21-27 YEAR OLD MALES



age range for accession standards: 21-30
age range for NHANESII mean value: 21-24

21-27 YEAR OLD FEMALES



note: age groupings for accession stds
subdivide the single male grouping

Accession weight standards do not permit females any significant leeway compared to the retention standards, while males obtain a very generous allowance. The female accession tables deviate from the normal physiological relationship of body mass index and give up to a 10 lb weight allowance for the shortest women but are actually more restrictive than retention weight screens for the tallest women. The male accession tables exclude very few otherwise eligible U.S. males, allowing up to 40 pounds over the retention screening tables. The accession table weights correspond to the average weight predicted for young males with 32% body fat.

Although any limiting standard drawn through the continuous range of observed body fat is necessarily arbitrary, the drawing of enforceable lines for fatness has effectively eliminated gross obesity from the U.S. Army. As a result of standards which they know they must meet, soldiers have been driven to exercise more and to be more careful about their eating habits. These positive aspects of the regulation are undermined by the mismatched accession regulation which injects more fat soldiers into the system. No new data collection is required to determine if there is a discrepancy between accession standards based on height-weight tables and retention standards which are based on body fat. Likewise, there is an obvious difference in the standards which have been set for men and for women.

This study was conducted to explore the relationship between these two standards for males and females. This was done by examining the relationship of excess fatness, as defined by current retention standards, to attrition, physical performance, and achievable weight and fat loss in new male and female recruits.

METHODS

This study was designed and conducted in response to a request from the Office of the Deputy Chief of Staff for Personnel, conveyed through the Office of the Surgeon General. The protocol was approved by the Human Use Review Board on 20 April 1988.

STUDY SAMPLE

The purposes and procedures of this study were explained to approximately 2000 new recruits and 1894 volunteered to participate and gave their written informed consent. Other routinely collected information such as APRT scores was tabulated from unit records for 2623 (96%) individuals in the training companies containing formal study subjects (Appendix H). Subjects were recruited from all female companies formed during the study (approximately 1 company/week). Participation was invited for all male soldiers in one or more companies per week, selected from a larger pool of subjects in order to roughly match the number of women in the study. Initial measurements were obtained between 11 September and 9 October 1988. The last group of recruits was followed through graduation from basic training on 16 December 88 and a final mailed followup of all subjects was performed approximately six months after the end of basic training.

The mean age of these recruits was 20.1 $\pm$3.3 (range 17-40) and 20.2 $\pm$3.5 (range 17-35) years for males and females, respectively. Distribution of the three principal ethnic groups represented was: for males - 58.7% white, 30.9% black, and 6.5% hispanic; and for females - 46.8% white, 44.6% black, and 6.2% hispanic. National Guard and Army Reserve Components comprised 20.4% of male and 22.8% of female basic trainees. Female recruits were assigned primarily to low aerobic demand specialties (17); three fourths were assigned to: 76Y (supply), 94B (cooks), or CMF 33 (signal specialties). No concentration of specialties was evident for male recruits. Detailed analyses of the diet (at this time) and physical activity (in a 1984 study) of Fort Jackson basic trainees are available in two previous USARIEM technical reports (18,19).

DATA COLLECTION

Data was collected as follows and as summarized in Table 2.

Reception Station data collected by study team. The consent form and an extensive activity and health history questionnaire (results to be reported separately) were completed by all subjects in groups of 100 or more. Height, weight, grip strength, flexibility, and circumferences for body fat estimation were measured directly. Height was measured without shoes. Weight was obtained and recorded for soldiers in stockinged feet, t-shirt, and either jeans or BDU trousers and belt. Circumferences were measured with a Gulick tape measure in accordance with procedures outlined in AR 600-9 (13 Feb 1987). Grip strength was measured with a dynamometer (20) and the mean of three trials was recorded. Flexibility was measured using a sit and reach device (21) and the mean of three trials was recorded.

Military Entrance Processing Station (MEPS) information obtained from recruits' medical records screening. Starting within 1-2 weeks after recruit arrival, individual medical records were screened for height, weight, age, and ethnic origin as recorded during the MEPS station inprocessing. These heights and weights are obtained from soldiers wearing only underclothing.

APFT data collected from unit records. APFT test results were obtained from unit records for all recruits who took the test. This test was administered by the third day of basic training and again in the last week of basic training.

Discharge and recycle data. All separation actions during the basic training period were documented for study subjects. This information was also obtained for study recruits continuing with Advanced Individual Training at Fort Jackson.

Six month post-basic training followup. Height, weight, and circumference measurements were obtained by surveys mailed to company commanders at the soldier's current duty station six months after graduation from basic training (Appendix I). These addresses were obtained from the Army Enlisted Masterfile. The printout from this file was performed at an average of 6.7

months after soldiers' completion of basic training. The disposition of unavailable soldiers was requested, if known. An initial mailing to 100 of the study soldiers was performed to test the questionnaire and the mailing list (using an earlier printout). A subsequent mailing to the remaining subjects was performed within 10 days of the receipt of an updated address list (21 July 89). Commanders were given a 20 day suspense from the date of mailing. A followup mailing to all nonrespondents (using the same address list) was made 20 days after the suspense for the first mailout. All returned surveys were analyzed 60 days after the last mailout (10 November). Surveys were returned for 75% of the subjects by their units.

DATA ANALYSIS

Data was analyzed with the SPSS-X statistical package (Chicago, ILL), using chi-squared analyses, t-test comparisons, and simple regressions. All EAD and basic training data was analyzed using the entire set of available recruit data. Comparisons between survey data and EAD data were made only for the subset of active duty soldiers with complete anthropometric data. Mean

Table 2. Data collected on recruits starting with basic training at Fort Jackson in Fall 1988.

MEPS station (retrospective)	Reception station (onsite study)	End of training (unit testing)	6-9 month followup (mailed survey)
height	height	height	height
weight	weight	weight	weight
	*APFT results	APFT results	
	circumferences		circumferences
	discharges----------	discharges	discharges
	flexibility		
	grip strength		

* results for the diagnostic APFT administered at the start of basic training are mixed with 1 mile and 2 mile run tests; APFT test results were obtained at the end of basic training with 2 mile run tests only.

values are shown ±standard deviations. All study team measurements were recorded in metric units. These have been converted to English units in the results section of this report for consistency with the regulation (AR 600-9) and to match the units used in other phases of the data collection.

Body mass index (wt/ht^2) was calculated for males and females in this study as the most appropriate unitary expression relating body proportion and size to fatness (22). An alternative index, $wt/ht^{1.5}$, has been suggested to be a more appropriate expression in prediction of weight for females; however, based on the results of a stepwise regression using data from the Army Body Composition Study, we found that for both males and females, BMI is a superior predictor of fatness.

The primary breakdown of data in this study was performed as a dichotomous "within" or "exceed" weight-for-height tables, or "within" or "exceed" fat standards. Distributions around these standards are expressed as a difference from the recruits' individual (age- and sex-specific) standards, in positive (exceed limits) and negative (within standards) BMI or % body fat units. Cutpoint values used in this data analysis are shown in Table 3.

Percent body fat was calculated according to the relationships listed below. Using English units of measure, these yield the same results as the current computation tables in AR 600-9, for the 1/4" intervals offered:

MALES: % BODY FAT = 46.89 - (68.68 * LOG (HEIGHT)) + (76.46 * LOG (ABDOMINAL CIRCUMFERENCE - NECK CIRCUMFERENCE))

FEMALES: % BODY FAT = (0.44 * HIP CIRCUMFERENCE) + (105.33 * LOG (WEIGHT)) - (1.31 * HEIGHT) - (3.99 * FOREARM CIRCUMFERENCE) - (1.35 * NECK CIRCUMFERENCE) - (0.51 * WRIST CIRCUMFERENCE) - 71.76

The reliability of MEPS and survey data was tested using team-measured height as a check measurement. These measurements by the MEPS and by soldiers' first units overestimated height by 0.9 and 1.1 cm (Appendix J). A 1.0

cm (0.4") overestimate in height reduces calculated body fat in the midrange of statures by 0.2% and 0.7% body fat units for men and women. To reduce the influence of this one source of measurement error, all body fat calculations were made using the initial study team measured height.

Table 3. Current Army standards of body mass index (BMI) and fatness by age category. Tables are shown in Appendix B & G. Note that BMI and %body fat are not numerically equivalent expressions.

1. Accession - height-weight standards (expressed as BMI)

	16-20	21-30	31-35	36-40
Male	30.9	31.9	31.7	30.8
Female*	22.8	23.7	24.4	24.9

2a. Retention - height-weight screen (expressed as BMI)

	16-20	21-27	28-39	40+
Male	25.9	26.5	27.2	27.6
Female	22.9	23.5	24.3	25.0

2b. Retention - body fat standards (percent body fat)

	16-20	21-27	28-39	40+
Male	20	22	24	26
Female	28	30	32	34

* BMI relationships are not consistent for female accession tables and produce sharp inflections below 64" in height; in this table BMI is given for women 66-67" but these standards were more precisely defined by height for "within" and "exceed" standards analyses in this report. An additional age category for women (21-24 and 25-30) has been collapsed into one category to match the male standard in this table; the more precise age breakdowns prescribed in the accession weight tables were used in the data analysis.

RESULTS

DISTRIBUTION OF NEW RECRUITS BY WEIGHT AND FAT STANDARDS

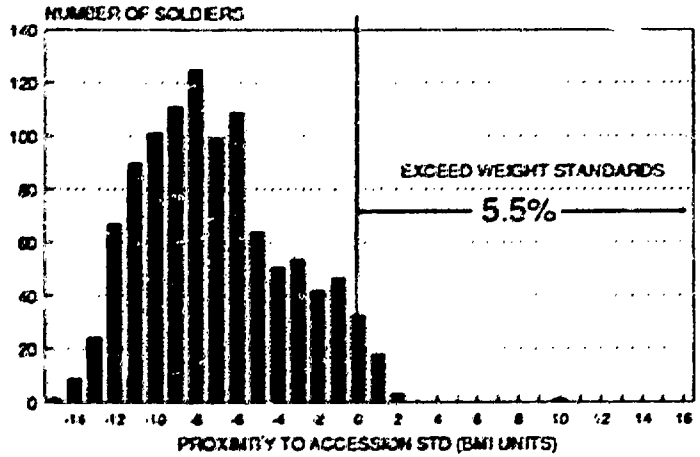
Distribution by weight standards (Figure 4, facing page). The distribution of recruits by accession and retention weight limits are shown in Figure 4. These are expressed as body mass index (BMI) units, to express weight-for-height correctly. A small percentage of men (5.5%) exceeded even the lenient male accession weight tables. A much larger proportion of these men exceeded the retention weight screen (30.8%), reflecting the large gap between the accession and retention weight tables for males. Although none of the overweight females exceeded the accession standard by much (at most, 3 BMI units), 32.1% were above the standard on entry to active duty and 36.9% exceeded retention screening table weights. (One BMI unit corresponds roughly to 6-7 lbs).

Fatness of new recruits (Figure 5, next page). The distribution of new recruits by percent body fat is shown in Figure 5. Mean body fat was 16.1 $\pm$5.8% for males and 26.8 $\pm$4.2% for females. Males averaged -4.6 $\pm$5.9% body fat units below their limit, while females averaged -1.8 $\pm$4.2%. Breakdowns by age and ethnic origin are shown in Appendix K.

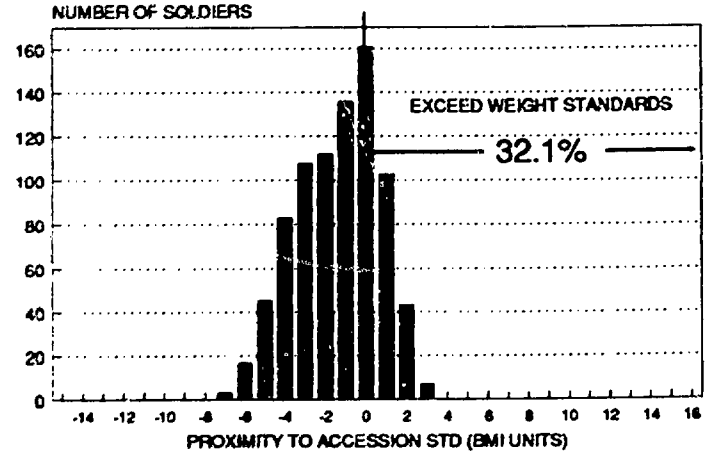
Distribution by fat standards, within weight standards (Figure 6). The distribution of new recruits with respect to the proximity to body fat retention standards is shown in Figure 6. Only 4 males out of 54 who were overweight by accession weight standards were within the retention fat standards. A large portion of the males who fell below accession weight standards, but who exceeded retention weight screen limits, met body fat standards (shaded portion, below fat limit). The highest body fat measured in a male recruit, acceptable by accession weight tables, was 34% or approximately 14% body fat units excess.

Compared to males, a large portion of females who exceeded accession weight standards were within retention body fat standards (10.9%). Theoretically, these women should not have been allowed into the Army, by the

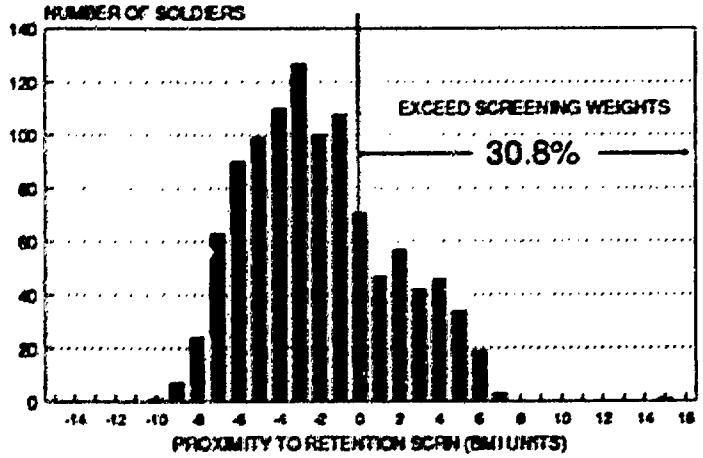
DISTRIBUTION OF MALE RECRUITS BY ACCESSION HEIGHT-WEIGHT STANDARDS



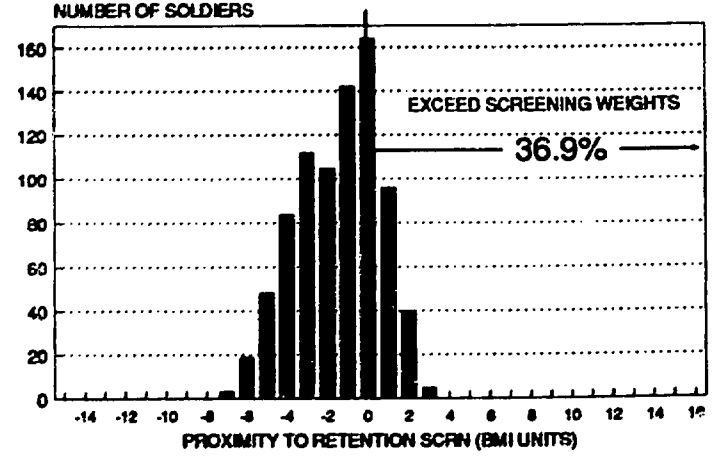
DISTRIBUTION OF FEMALE RECRUITS BY ACCESSION HEIGHT-WEIGHT STANDARDS

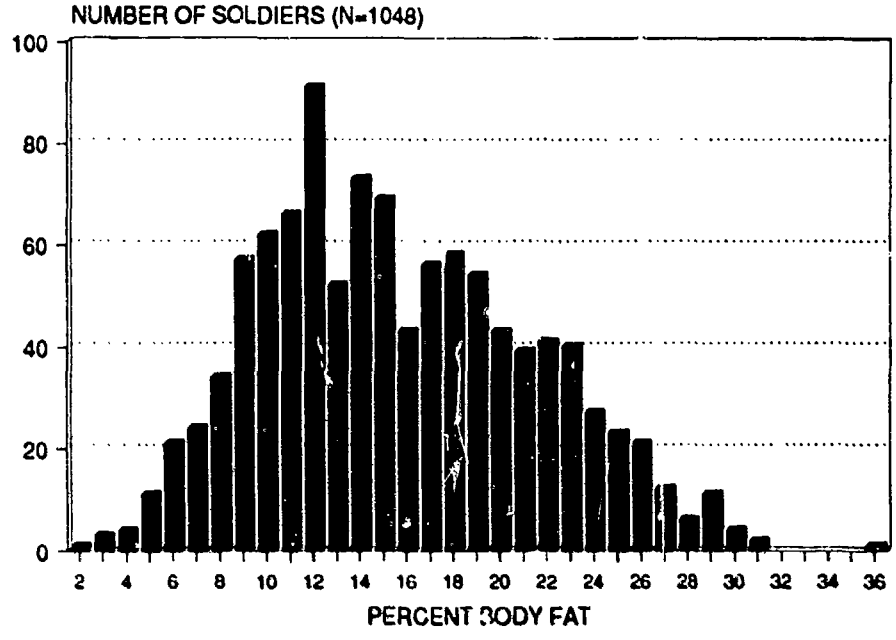


DISTRIBUTION OF MALE RECRUITS BY RETENTION SCREENING HEIGHT-WEIGHTS



DISTRIBUTION OF FEMALE RECRUITS BY RETENTION SCREENING HEIGHT-WEIGHTS




%BODY FAT OF MALE RECRUITS AT EAD
determined by AR 600-9
NUMBER OF SOLDIERS (N=1048)
100
80
60
40
20
0
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36
PERCENT BODY FAT

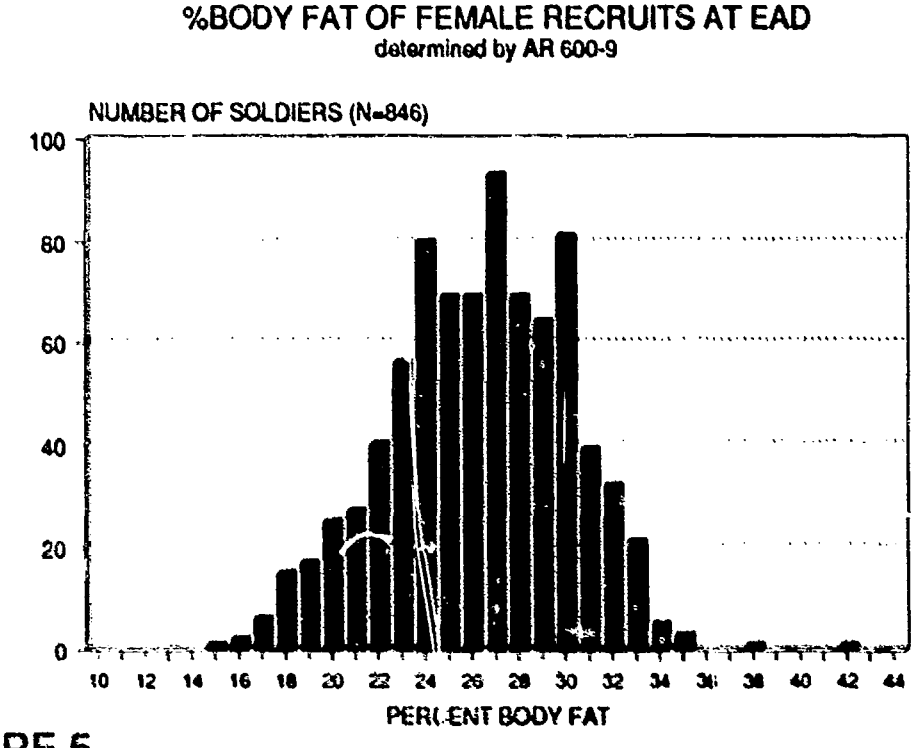

%BODY FAT OF FEMALE RECRUITS AT EAD
determined by AR 600-9
NUMBER OF SOLDIERS (N=846)
100
80
60
40
20
0
10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
PERCENT BODY FAT

FIGURE 5.

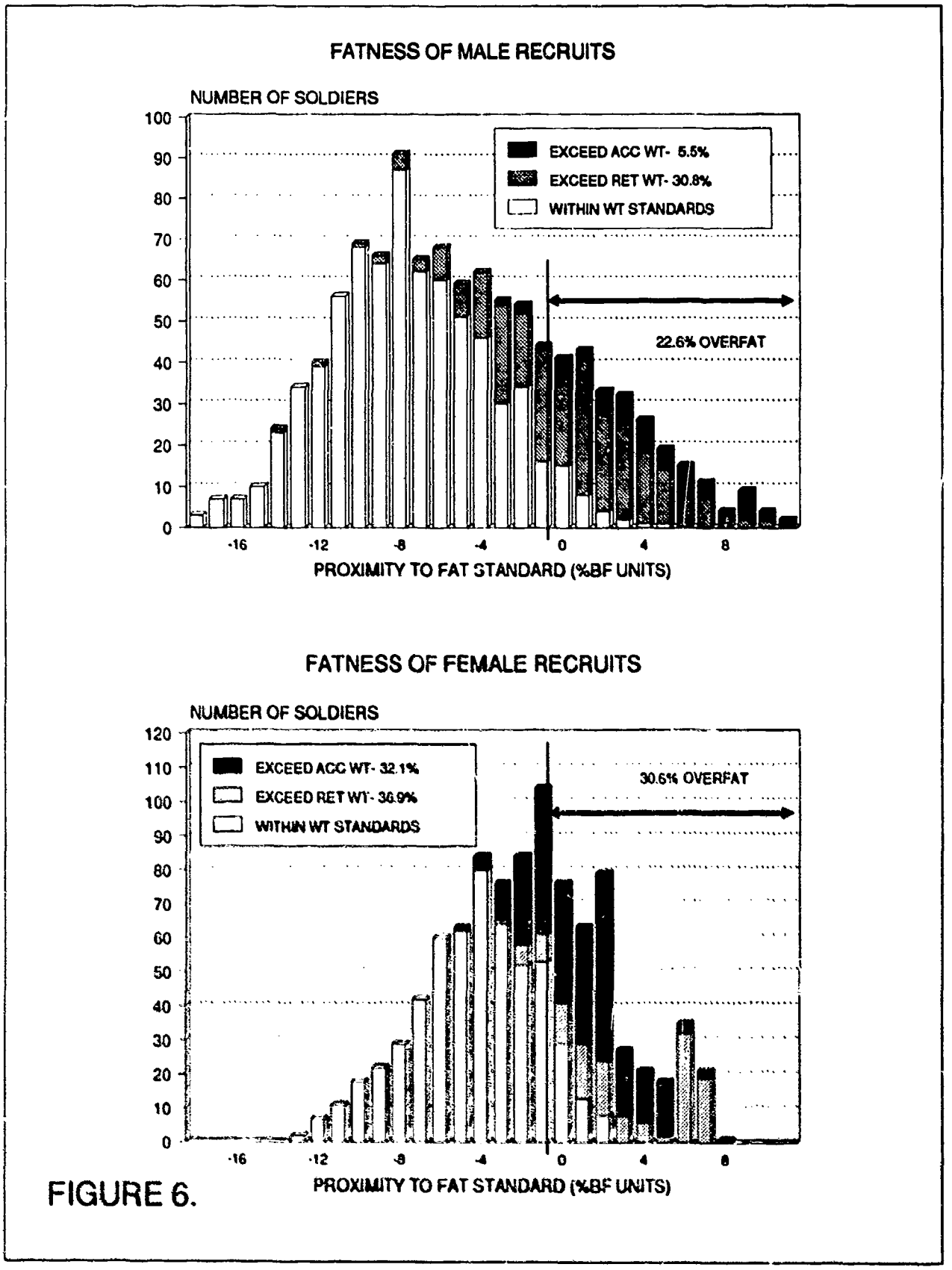

FATNESS OF MALE RECRUITS
NUMBER OF SOLDIERS
100
90
80
70
60
50
40
30
20
10
0
EXCEED ACC WT- 5.5%
EXCEED RET WT- 30.8%
WITHIN WT STANDARDS
22.6% OVERFAT
-16
-12
-8
-4
0
4
8
PROXIMITY TO FAT STANDARD (%BF UNITS)
FATNESS OF FEMALE RECRUITS
NUMBER OF SOLDIERS
120
110
100
90
80
70
60
50
40
30
20
10
0
EXCEED ACC WT- 32.1%
EXCEED RET WT- 36.9%
WITHIN WT STANDARDS
30.6% OVERFAT
-16
-12
-8
-4
0
4
8
PROXIMITY TO FAT STANDARD (%BF UNITS)

FIGURE 6.

directives in force at the time of this study. Presumably, others in this category were turned away by recruiters for failing to meet the accession weight standards.

The distribution of females around their fat standards represents a narrower range than the distribution of men. The minimum portion of new recruits who would qualify for the Army Weight Control Program if they were immediately held to the regulation, are depicted in the shaded (including solid shading) areas which span the overfat region. 19.7% of all new male recruits and 25.4% of the female recruits fall into this category of overweight and overfat.

ATTRITION AND FATNESS

A summary of separations and known reasons for separation is shown in Table 4. Overall attrition rates are estimated as the sum of the basic training rate (all soldiers studied) and all losses in the period following basic training (National Guard & Army Reserve soldiers not continuing on active duty are censored from the rate). These rates were roughly 15% for males (5.3% in BT, 9.7% after BT) and 40% for females (7.2% in BT, 34.1% after BT). Five times as many females as males attrited from active duty after basic training but before the survey ("Attrited before survey", in Table 4). Thus, attrition in basic training was higher for females compared to males (relative risk = 1.4; chi-squared analysis, $p<0.05$), and this risk further increased for females in the 6 months after basic training (relative risk = 3.5; $p<0.001$).

The reasons for this attrition are not known but it is evident that female attritees were not fatter than retained soldiers. It is also clear that the relationship between success in the Army (i.e. retention) and body composition is different between males and females. On a univariate level, there is a trend for increased attrition in males with increasing fatness (correlation coefficient = 0.72, $p<0.01$), while the female relationship, if anything, reflects a decreasing risk of discharge with increasing percent body fat (correlation coefficient = -0.37, $p=0.29$)(See Figure 7 which shows attrition rates for the subset of recruits with known body composition).

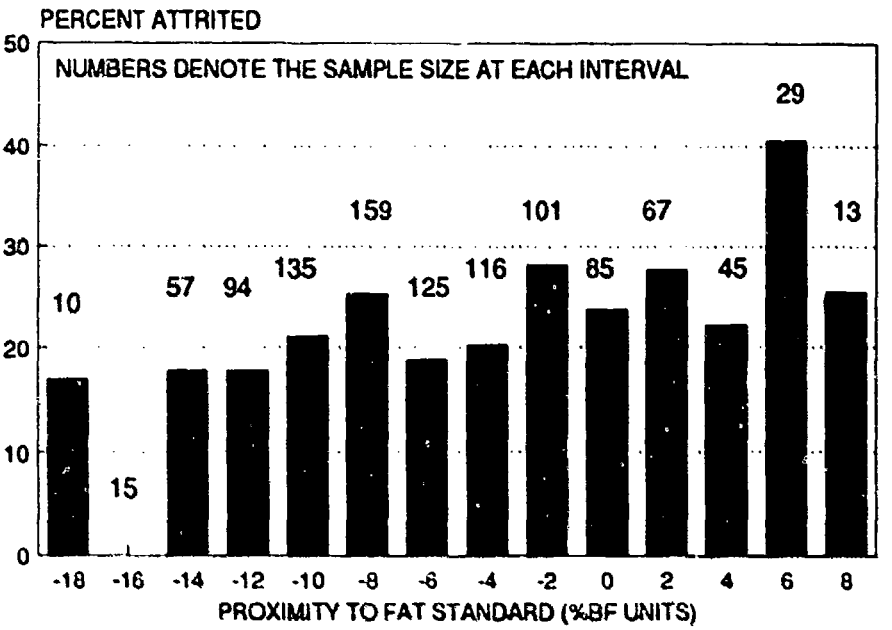
Table 4. Summary of identified separations in the study group.

Chapter/type of separation	Basic training M	Basic training F	First unit M	First unit F
5-11, Medical fitness*	38	39	4	2
5-13, Personality disorder	0	3	1	6
5-15, Weight control failure	--	--	2	0
5, Unspecified, Convenience of Service	7	5	0	2
6, Hardship/dependency	0	1	1	0
8, Pregnancy	--	--	--	5
9, Alcohol & Drug Abuse	0	0	1	1
10, Good of the Service	--	--	1	1
11, ELS performance & conduct	32	23	2	7
13, Unsatisfactory performance	--	--	2	1
14, Misconduct	0	0	3	0
15, Homosexuality	2	0	0	0
Unidentified separations**	2	7	24	32
Dropped from rolls	0	1	4	1
ATTRITED BEFORE SURVEY	--	--	57	228
Total separations	81	79	102	286
total in each sample	1531	1092	1047	838
% of each sample	**5.3**	**7.2**	**9.7**	**34.1**

* primary diagnoses given for medical discharges during basic training were: asthma (10 males, 3 females) and pes planus/cavus (8 males, 11 females).

** these were usually surveys returned from a Separation Point address.

ATTRITION OF MALE SOLDIERS BY INITIAL FATNESS



ATTRITION OF FEMALE SOLDIERS BY INITIAL FATNESS

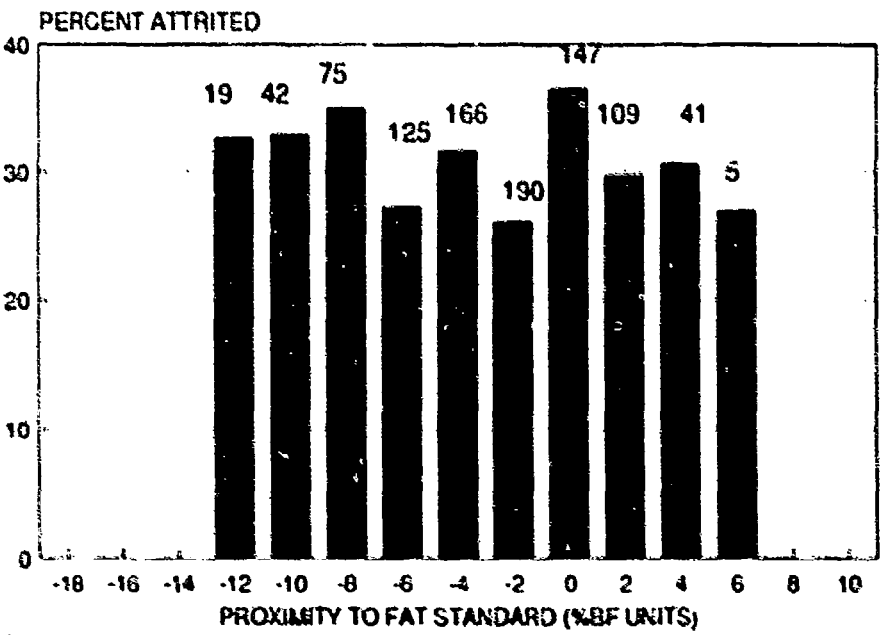


FIGURE 7.

It is not surprising then that males who were overfat by retention standards when they entered the Army had a greater risk of attrition than males who were within standards (relative risk = 1.3, p=0.09), while overfat females had about the same risk as initially within-standards females (relative risk = 1.1, p=0.32). The most significant relationship to emerge between body composition and attrition for males or females was that heavy females (high BMI, not necessarily high body fat) were at lower risk of attrition. Thus, the females who exceeded the weight screening tables for retention standards were more likely to be successful in the Army (relative risk = 0.7; p<0.001).

A more sophisticated multivariate analysis was performed using a logistic regression to compare measures of fitness (2 mile run time, push ups, sit ups), fatness, and BMI against attrition. For males, run time was the only variable associated with attrition, replacing the body composition measures which are weaker factors of the same fitness variable. For females, body fat was a significant factor, while situps and BMI were inversely related to attrition. Thus, for males aerobic fitness is a better predictor of discharge than percent body fat while in females the model indicates that both BMI and body fat are predictive of attrition, with BMI being a protective factor. Thus, females who are strong and overweight (but not overfat) are more likely to succeed during their initial period of Army service.

PHYSICAL PERFORMANCE AND FATNESS

The relationship between fatness or body weight and physical performance, as measured primarily by initial APFT performance is shown in Table 5. Performance measurements were consistently lower (run times were increased) for males exceeding retention fat standards compared to within-standards males, but these differences were less evident for females sorted on the basis of their fat standards. Even though all APFT values were markedly improved by the end of basic training for both males and females, and even though substantial weight loss was achieved in the overfat or overweight males and females, differences in performance between the initial groupings persisted. The differences for males may have been even more pronounced since 22.6% of overfat males did not take the final APFT, compared to only 12.6% of males

Table 5. Mean values of physical performance measures for recruits, compared by retention BODY FAT STANDARDS at EAD.

	Males			Females		
	Within	Exceed	p	Within	Exceed	p
Percent body fat	13.7 ±4.0	24.0 ±2.6		24.8 ±2.9	30.8 ±1.9	
Push ups (count)	32.0 ±12.3	26.0 ±11.5	<0.001	10.9 ±7.5	8.8 ±6.5	0.001
Push ups (count) end of basic training	52.7 ±12.4	46.7 ±11.2	<0.001	28.4 ±9.6	26.2 ±9.8	0.005
Situps (count)	45.2 ±10.8	37.7 ±12.1	<0.001	35.1 ±14.1	32.0 ±13.1	0.007
Situps (count) end of basic training	65.6 ±11.3	60.7 ±10.6	<0.001	61.9 ±10.9	60.4 ±12.7	0.12
One mile run (min)	7.37 ±0.80	8.36 ±0.89	<0.001	10.37 ±1.83	10.89 ±2.03	0.018
Two mile run (min)	15.97 ±1.88	17.90 ±2.42	<0.001	20.17 ±2.37	20.65 ±2.18	0.08
Two mile run (min) end of basic training	13.87 ±1.08	14.69 ±1.05	<0.001	17.31 ±1.50	17.69 ±1.40	0.002
Flexibility (inches)	33.4 ±7.0	33.0 ±6.5	0.45	34.2 ±6.2	34.2 ±5.9	0.98
Grip strength (lbs)	119.4 ±20.0	121.3 ±21.9	0.26	69.0 ±13.8	65.0 ±11.7	<0.001

note: probability indicates results of t-test comparison between groups.

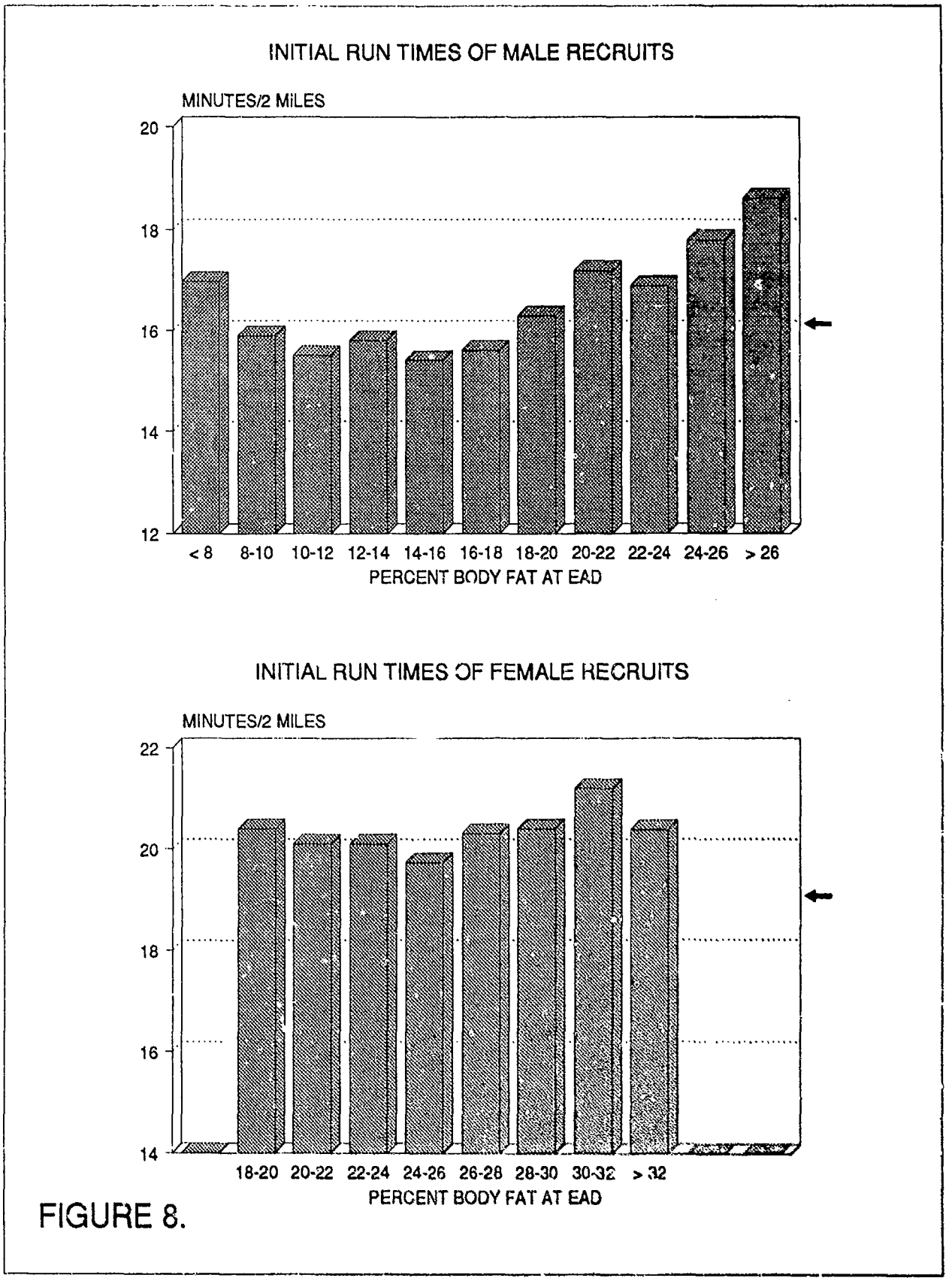

INITIAL RUN TIMES OF MALE RECRUITS
MINUTES/2 MILES
20
18
16
14
12
< 8
8-10
10-12
12-14
14-16
16-18
18-20
20-22
22-24
24-26
> 26
PERCENT BODY FAT AT EAD
INITIAL RUN TIMES OF FEMALE RECRUITS
MINUTES/2 MILES
22
20
18
16
14
18-20
20-22
22-24
24-26
26-28
28-30
30-32
> 32
PERCENT BODY FAT AT EAD

FIGURE 8.

below retention fat standards (chi-squared test, p <0.001). An even larger proportion of female recruits failed to take the test but there was no difference with respect to retention body fat standards (26.6% "within" vs 27.4% "exceed"). Thus, the fatness of males not represented in the final APFT results was 17.4±6.7 compared to 15.9±5.6% body fat for all males taking the test (t-test, p <0.001) while there was no difference in the average fatness of females taking the test (26.7±3.7% body fat) and those not taking the test (26.9±3.7% body fat).

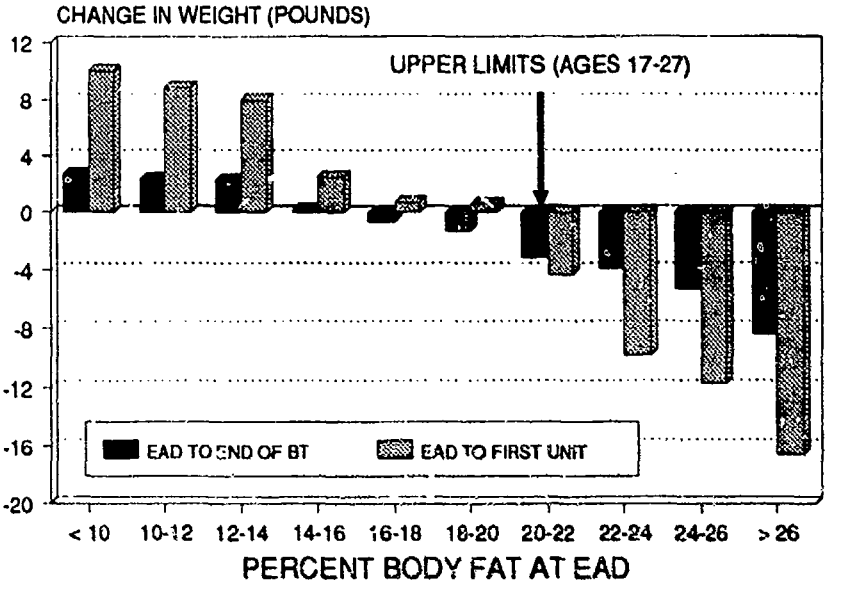
The relationship between run time and fatness at EAD is depicted in Figure 8. For males, run time performance worsens with increasing fatness above 18-20% body fat. Mean run times for males above this level of body fat did not achieve the minimum 2-mile run time standard set for the youngest men (right hand arrow). Correlations suggest a trend for both males and females, with a tendency for fattest males and females to produce slower run times, but the slightly bimodal relationship between fatness and run time is much flatter for females. Mean values for female recruits did not achieve the minimum run time standard set for the youngest age category at any interval of percent body fat.

The relationship between strength, based on grip strength measurements, and BMI is illustrated in Appendix L for within-fat standards recruits. The recruits with the lowest BMI had the lowest strength measurements.WEIGHT

LOSS AND ACHIEVABLE CHANGE IN BODY FAT

Weight loss in basic training (Figure 9, facing page). Weight loss during basic training was greatest in the fattest recruits. Mean change in weight compared by initial (EAD) fatness is shown for males and females in Figure 9. Females lost weight at all intervals of fatness but, individually did not lose as much weight as males in the upper ranges of fatness. Thus, overall changes were -0.4 ±6.8 lbs (males) and -2.5 ±5.7 lbs (females) but the changes within subgroups by fat standards were +1.0±6.3 and -5.1±6.4 lbs for within- and exceed-fat standards males, and -1.9±4.3 and -3.2±4.1 lbs for females, respectively.

CHANGE IN BODY WEIGHT OF MALE SOLDIERS
DURING BASIC TRAINING & 6 MTHS LATER



CHANGE IN BODY WEIGHT OF FEMALE SOLDIERS
DURING BASIC TRAINING & 6 MTHS LATER

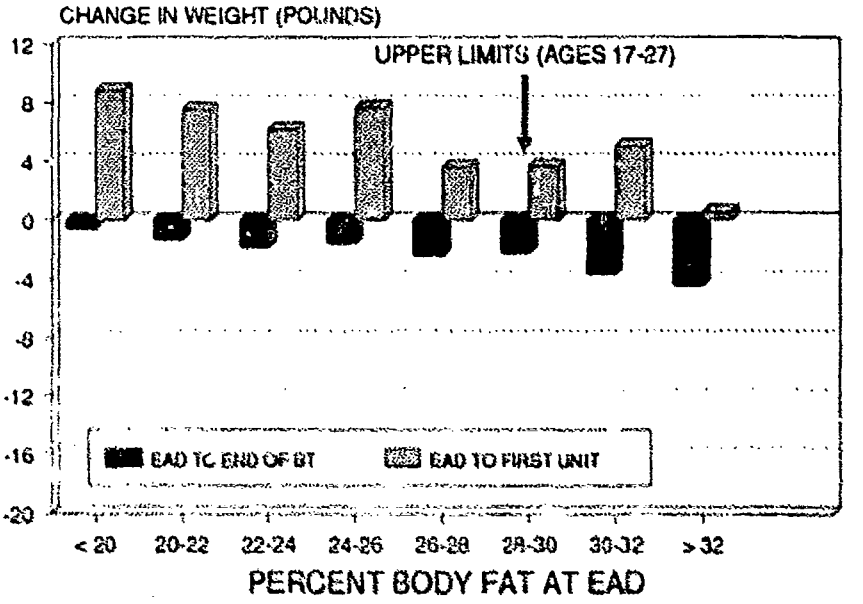


FIGURE 9.

Weight change between EAD and 6 months after basic training. Following basic training, male weights continued to change in the same direction taken in basic training, while females at all fatness intervals regained lost weight and added more weight (Figure 9). Overall changes (from EAD to 6 months after basic training) were +1.9 $\pm$11.9 lbs (males) and +4.8 $\pm$7.9 lbs (females). The leanest females lost the least amount of weight during basic training and gained more weight at their first unit, compared to females at higher levels of fatness.

Distribution by fat standards, EAD compared to first unit. Fifty-three percent of male soldiers who were overfat at EAD met their fat standards when surveyed six months after basic training. The proportion of overfat males decreased from 23.1% (EAD) to 13.3% (6 months)($p < 0.01$). Males less than 4% body fat units over their fat limit at EAD achieved a mean decrease of 2.9$\pm$3.0 % body fat units, 6 months after the end of basic training. Units reported that 5.8% of all the studied males were on the Army Weight Control Program.

Within the sample of retained females with complete data, 35.4% exceeded fat standards at EAD and 30.7% exceeded standards 6 months after basic training. The proportion of initially overfat females who later met their fat standard was significantly less than for initially overfat males (35% of overfat females vs 53% of overfat males, met standards later; $p = 0.02$). This was also reflected in a smaller mean decrease of 1.4$\pm$3.7 % body fat units for females initially less than 4% over their fat limit. Units reported that 8.9% of the studied female soldiers were on the Army Weight Control Program, six months after basic training. Pregnant soldiers were excluded from all weight and fat analyses.

DISCUSSION

Since the early 1980's, the Army has placed increased emphasis on a trim military appearance. This policy has been implemented and rigidly enforced through an expanded program which has become integral to the Army, from mandatory biannual weigh-ins of all personnel to the display of weight and height on personnel efficiency reports. This emphasis is a result of the leadership's conviction that trim appearance is indicative of a disciplined, motivated and combat-ready soldier. This program is currently handicapped by the existence of two separately developed and unconnected Army Regulations that bear on weight control, one which allows overfat soldiers into the Army (AR 40-501, Medical Fitness Standards) where they will be in violation of the second (AR 600-9, The Army Weight Control Program). Logic would suggest that the two should be linked, with the accession standard based on the retention standard. The retention standard, in turn, should be based on objective criteria, e.g. physical requirements for a combat performance test. This is also not the case.

The results of this study not only allow us to address the original issue, gender bias in the accession standards, but also allow us to address a number of issues and problems created by these two disparate programs.

EFFECT OF ACCESSION WEIGHT STANDARDS ON SOLDIER FATNESS

The purpose of accession weight tables is to screen out individuals who are unlikely to be successful in the service. This lack of success includes the inability to meet retention fat standards. The current accession weight tables permit entry of virtually all otherwise qualified young males, including some very fat males who are unlikely to ever achieve retention fat standards. Even so, the proportion of overfat male recruits who are accepted under these lenient standards is relatively small (23.1%). This is due to the fact that most young males in the U.S. population are considerably below the Army fat standards and further opening this wide window does not increase the candidate pool as much as a similar increase would for females. Most young females in the U.S.

population are clustered near the retention fat standards for females, i.e. the standard is only 1.2% body fat units above the mean fatness of new recruits, a difference which is within the margin of error of most methods of body fat estimation. This results in a considerable spillover into the overfat range. Thus, even though the female accession weight standards are not more lenient than the retention weight screening tables, 30.6% of all new female recruits are overfat by Army standards. None of these recruits are very fat by comparison to national averages and most only slightly exceed the Army standards. One fourth of all female recruits exceeded the standard by less than 4% body fat units (equivalent to 5 or 6 pounds of fat weight in an average female recruit).

These various standards and averages can be better appreciated if the same property (ie. percent body fat) is compared. Body fat is used for individual assessments in the Army Weight Control Program because it more directly reflects obesity than body size (weight-for-height), but the two are somewhat correlated and an average fatness can be predicted for a group of recruits of given body mass index. Accordingly, Table 6, below, shows percent body fat equivalents estimated from body mass index using regressions from our current Army recruit sample. These values for percent body fat demonstrate the sizeable allowance for male fatness between the accession and retention standards, and again between the retention standards and the national average. Females are not granted a similar allowance. The approximated body fats allowed for females are virtually identical to the national average, for both the retention fat limit and the accession fat limit equivalent.

The effect of the proposal from the Defense Manpower Data Center to set accession weight standards at 120% of the national mean (3) can also be clearly observed in this comparison. The proposed change would increase the limit by approximately 10 percent body fat units over the national mean for both men and women. While this would exclude more equal proportions of males and females from Army service, it would also produce a very large increase in the proportion of overfat female soldiers by raising the upper range of entry level fatness. Without a change in retention standards, this would substantially increase the proportion of female soldiers, compared to male soldiers, subject to the punitive measures of the Army Weight Control Program (compare

Table 6. Percent body fat (actual or equivalent) of recruits, retention and accession standards, and national averages. Note that percent body fat increases faster than body mass index, thus 20% over the average weight (for height) is reflected in this table as a 50-60% increase in fatness of males and a 33% increase in fatness of females.

	Males			Females		
Age category -->	17-20	21-27	28-39	17-20	21-27	28-39
Recruits in this study (mean value)	15.6	17.0		26.8	26.3	
Retention fat stds (upper limit)	20	22	24	28	30	32
*Accession weight tables (upper limit)	(32)	(34)	(33)	(28)	(30)	(32)
*NHANESII weight (mean value)	(15)	(19)	(20)	(27)	(30)	(33)
*120% of NHANESII	(24)	(29)	(30)	(36)	(40)	(44)

* estimated from regression of body mass index and percent body fat estimated by AR 600-9, from all new recruits in this study. Equations: males: %body fat=(BMI-14.67)/0.511, r=0.82, n=1048; females: %body fat=(BMI-9.89)/0.459, r=0.86, n=816.

"retention fat standards" to "120% of NHANESII" in Table 6). Besides raising the average fatness of new recruits, this approach represents an arbitrary quota linked to a gradually changing national average.

Mean weights in the national population have increased over the past decade for specific segments of the population. Obesity is variously reported to be epidemic in older black females (23), increasing in poorly educated women (24), and more prevalent in hispanic males and females (25).* Concern is

* Our sample of Army recruits are already selected on the basis of the accession weight tables and include a younger age sample than these obesity studies. Accordingly, our sample does not reflect these trends; black male and black female recruits had significantly lower percent body fat in our study.

expressed about the health of these overweight minorities but this obesity is defined only with respect to national weight averages which reflect the norms of predominantly middle class young white men and women. Its true significance in terms of health risks in minority ethnic groups may not be the same as in the more studied middle class white population and this health-related standard is not even theoretically related to the principal goals of the Army Weight Control Program (combat readiness and military appearance). Regardless of the health relationship, body weight (BMI) to body fat relationships vary between ethnic groups (26-28). Thus, linking obesity standards to national weight averages is not only arbitrary and ever changing, it is likely to be arbitrarily discriminatory to some minorities, especially non-white females.

RELATIONSHIP OF ACCESSION STANDARDS TO ATTRITION AND PHYSICAL PERFORMANCE

In this study, fatness did not appear to be a principal reason for attrition from the Army. Nor was fatness or weight a principal discriminant of attrition in a previous study from this Institute, performed on basic recruits at Fort Jackson in 1978 (29). In that study, mean body fat (as estimated from skinfold thicknesses) of the male and female recruits was 16 and 28%, body mass index was 23 and 22 kg/m^2, and the initial one mile test times were 8.2 and 11.0 minutes (10,11), indicating little change in the fitness and fatness of recruits over the past decade. The principal determinants of attrition at that time were psychological factors, comparative fitness, and age. Attritees scored poorly on psychological inventories (assessing locus of control and tendency to psychosomatic illness) and they tended to be older and had a reduced comparative fitness level (lower levels of physical fitness when asked to compare themselves with other men and women their own age), but these determinants accounted for only a small proportion of the attrition, with most remaining unexplained. Despite the similarities in the characteristics of recruits in the previous and current studies, the rates of attrition during basic training were higher (12.1% for men and 11.9% for women) than the rates obtained in the current study (5.3% for men and 9.7% for women). This suggests that attrition rates are determined by policies governing soldier discharges from basic training, in addition to specific characteristics of the recruits.

Our study does not assess attrition due to failure to meet weight control standards since soldiers are generally given six months to achieve standards before any separation actions are initiated. The timing of our followup survey avoided this complication which would have been reflected as an increased attrition in the higher body fat and body weight range. This is a significant reason for attrition after the first few months of service. Separations from the Army for failure to meet weight control standards have increased sharply in the past three years, with over 2,000 soldiers separated in 1989 (unpublished data, ODCSPER).

Male attritees in the previous study at Fort Jackson (29) also had significantly lower lean body mass. This is similar to our current finding that overweight (but not overfat) females were underrepresented in the attrited sample and it supports the notion that underweight and weak recruits are less likely to succeed than overweight recruits. We also found that recruits with the lowest BMI had the lowest average grip strength for both males and females, further illustrating the positive relationship between strength and size.

Using a much larger sample, the Defense Manpower Data Center study found a gradual rise in attrition rate among recruits who exceeded the national average weights, beginning above a BMI of 26 kg/m^2 and, at the other end, with a sharp rise beginning below 16 kg/m^2; the range of female weights was already too constricted to determine the possibility of a similar relationship (5). A relationship at the low end of BMI can be rationalized in terms of inadequate muscle mass for performance of military duties and/or low weight as a symptom of underlying disease. Reasons for male attrition associated with high BMI are unknown but clearly different, and apparently these have diminished over time. A more recent study reexamining weight and attrition from the military reports a sharp decrease in Army attrition rates between FY82-84 and FY85, with essentially a flat line representing attrition rate plotted against BMI in FY85 (30). This is consistent with our findings.

For nearly all components of the APFT, overfat males and females in this study could not perform as well as those within the retention fat standards. These differences in physical performance were greater for males than for

females. This may reflect basic sex differences in the relation between physical performance and fatness but it also likely reflects the lower level of physical fitness of the female recruits at any level of fatness and the narrower relative range of fatness of our female recruits. The accession weight standards already exclude females in the higher ranges of body fat and the span of difference between mean fatness of the two groups of females was smaller (6% body fat units) compared to a span of over 10% body fat units between the two male groups. However, these results are further confounded because overfat males were less likely to take the APFT, compared to within-standards males. The net effect of this is to make scores closer instead of more disparate. While there was no apparent difference in female APFT participation on the basis of fat standards, an even higher proportion of all females than of the overfat males failed to take the test, possibly introducing other unidentified confounders. Within the context of this study's limitations, the current retention fat standards appear to be better discriminators of physical performance in male recruits than in female recruits. Based on initial 2-mile run times, 20% body fat is an appropriate standard for young males, since this is the breakpoint above which two mile run time progressively increased (ie. aerobic performance decreased) in new recruits. The range of female fatness in this study group does not encompass a break point. In other words, the retention fat standards can be related to physical performance in males, while this remains to be demonstrated for the female standards.

LINKAGE BETWEEN ACCESSION AND RETENTION STANDARDS ON THE BASIS OF ACHIEVABLE FAT LOSS

Observed changes in weight and circumference-based fatness provide some rationale for different allowances between retention and accession standards for males and females. Males who exceeded their retention standard by up to 4% body fat were likely to achieve their fat standard by six months after basic training. This suggests that males, young males, as an example, could be allowed 24% for accession and be expected to meet the current retention standard of 20% body fat within a six month period of time after basic training. Males and females were both clearly capable of significant weight loss during basic training but only the overfat males maintained this weight loss.

Although some overfat females later achieved their standards, a larger proportion of overfat females, compared to overfat males, did not. Others, who were just under their fat standards at EAD, exceeded their fat limit by the time of the survey. Thus, the proportion of overfat females at their first unit was no different than the proportion when they first entered active duty, even though some transient weight loss was accomplished in the interim period of basic training. The reasons for this gender difference are unknown but may be attributed to motivational differences related to differences in the current standards, differences in the physical demands of assigned specialties, differences in recreational physical activity and other social factors, and physiological differences in fat regulation. The reasons for this discrepancy need further study before an accession fat allowance above the current retention fat standards could be justified for females.

At least a partial explanation of the weight gain in females following basic training resides in the type of job that recruits were likely to move on to. Nearly all of the assigned job specialties for females in this study group are rated as sedentary, while males were assigned to many jobs which require a high level of aerobic and/or strength capability and involve a high level of regular physical activity. The temporary weight loss in basic training indicates that the longer term outcome might be improved if effective weight loss assistance in terms of exercise and reduced caloric intake was provided to overfat soldiers. Currently, the level of this assistance is determined by the unit commander; presumably, most programs will be directed as only an extra duty by a soldier who serves as the unit Master Fitness Trainer. Our results suggest that female soldiers fresh from basic training should be prime targets of an effective fitness program.

Although a change to body fat accession standards would ensure accession of recruits who would be better able to comply with the standards of the Army Weight Control Program, the availability of recruits could change substantially, especially for females. An allowance of 4% over each of the current age standards would exclude 8.5% of the males currently recruited (Table 7). With no allowance (i.e. accession standards = retention standards), 22.7% of current male recruits would be excluded. The effect of an accession allowance is more dramatic for female recruits because of the clustering around the upper limit. If

Table 7. Percent of new male and female recruits affected and total excluded with allowances above retention body fat limits.

%body fat units above standard	% Males in group	Cumulative % excluded	% Females in group	Cumulative % excluded
no allowance	---	22.7	---	31.6
+ 0-2% body fat	8.0	14.7	14.6	17.0
+ 2-4% body fat	6.2	8.5	11.9	5.1
+ 4-6% body fat	4.3	4.2	4.4	0.7
+ 6- % body fat	4.2	0.0	0.7	0.0

candidates were held to retention body fat standards, 31.6% of all current female recruits would be excluded (12.6% of the remainder would later become overfat). A 4% allowance above the current fat standard would exclude only 5.2% of current recruits. This loss of eligible female candidates would be partially offset by an unknown proportion of overweight but within-fat standards females who were excluded from this sample of recruits. However, since the time in which our data was collected, recruits are being accepted if they meet either the accession weight tables or the retention body fat standards. Thus, a change to the current female retention body fat standards could only reduce current recruitment.

It is also apparent from this study that the concern about accession standards treating males and females with equal fairness needs to be extended to the retention standards. Specifically, female retention body fat standards should be reconsidered since the current standards may be physiologically more stringent for females than for males. As an illustration, males might have considerably more difficulty in achieving and maintaining their fat standards if their upper limit was only 1.5 percent body fat units above their average fatness, as it is for the young female recruits. A body fat standard equated on this basis would be 17% instead of 20% for young males. In view of the weaker relationship between female fat standards and performance, a more appropriate adjustment is to elevate the standard for young female soldiers from 28% to 30 or 31% body fat.

SEX DIFFERENCES IN FAT DISTRIBUTION AND REGULATION

Primary conclusions from this study about changes in body fat are derived from the use of the current Army circumference equations for predicting body fat. These equations were developed from a cross-section of soldiers at one point in time and have not been tested for suitability in evaluating small or short-term changes in body fat as employed here. Thus, their suitability for the accurate assessment of body fat change is unknown. Several studies (31-33) indicate that anthropometric estimations of body fat are relatively insensitive and should not be used to predict small or acute change. Furthermore, the male and female equations, using different measurements, may not estimate body fat changes to the same degree of accuracy in both genders or in certain types of individuals.

Despite these limitations and qualifications, other evidence suggests that the differences in the ability of overfat male and female recruits to meet their standards after basic training are real. This evidence comes from other measurements in the study and from other studies of sex differences and region-specific differences in fat loss. To begin with, females almost certainly lost body fat during basic training, since at all levels of fatness there was a mean reduction in weight, even while lean body mass may have been increasing (34). Following basic training, there was a mean increase in weight at all intervals of fatness. This can be reasonably assumed to be due to fat rather than lean body mass gain, since exercise levels for most soldiers would have been greatest during basic training, not after basic training. A gain in fat weight is also consistent with a previous study from this Institute which followed a small sample of female West Point cadets over a two year period, finding an initial reduction in body fat when the training was intensive, and then a gradual increase to higher than initial fatness (35). In the current study, hip circumference (weighted against "fat" in the female equation) increased by more than 1/2" between EAD and 6 months after basic training. Along with the average 5 lb gain in weight, these two factors represent a theoretical increase of approximately 2% body fat units for the typical 125 lb female recruit. These estimations are offset by increases in neck, arm, and wrist circumferences which represent lean body mass in the equation. Thus, observed changes in

the actual measurements used in the body fat equation also suggest that there was no significant mean female fat reduction, even though a transient reduction probably occured during basic training.

There is also a physiological rationale why females are less likely to decrease fatness to meet their arbitrarily set retention standards. In contrast to males who may be protected from fat accumulation by their sex steroids, in females fat storage is promoted by estrogens. Estrogens enhance accumulation in specific sites such as the gluteofemoral region (buttocks, hips, and thighs), creating the typical female pear shape (36-38). Females deficient in estrogen, such as postmenopausal women not treated with estrogenic steroids, tend to lose the pear shape for lack of a continued estrogen effect. Normal females also have a different balance of internal and subcutaneous body fat than men, with a greater proportion of subcutaneous fat (39-40); thus, they "wear" more of their fat on the outside. There are significant differences between these various subcutaneous sites in terms of the type of fat and its likely function (which may be protective, structural, or energy storage) and this varies with race as well (41). As an example of these specialized functions, the accumulation and mobilization of breast and thigh fat is largely determined by hormones important in pregnancy and lactation (42). Thus, thigh fat, one of the most immovable fat stores, may be primarily mobilized by hormones secreted during lactation, while being relatively uninfluenced by exercise and caloric restriction (43-45).

This also means that the female site which is assessed in the female fat equation, the hip circumference, is one which is reasonably susceptible to exercise and diet control both in terms of fat mobilization and accumulation. Fat stores which may be under less voluntary control by the individual, such as thigh fat, are not. Furthermore, due to the absence of high levels of male sex hormones, normal females do not have the same capacity to increase muscle mass as males. This means that, with less variability from muscle mass, weight is better associated with total fatness in females than it is in males and is also appropriately selected as a component of the fatness prediction. The waist circumference used in males is probably not appropriate for fat estimation in Army females. Abdominal fat is found in excessively obese women (when it

would also be measurably increased on the hips and in total body weight), but it is also found in women who are more masculinized, as characterized by excess fat in an "apple" instead of "pear" configuration (46-47). While women with this male type pattern of fat deposition may carry excess fat, these are also some of the women likely to be able to develop the greatest muscularity (48) and upper body strength. An abdominal measurement in females would discriminate against this specific subset of women who may be among those most suited to performance of some standard Army physical tasks.

Differences between male and female fat physiology and the relationship between fatness and military goals are not taken into account by the simple addition of 8% body fat to male standards. Excess fatness in males can be shown to be negatively related to military performance (physical performance and military appearance) but female fatness within reasonable limits of non-obesity is not as well correlated. Because different fat sites in females serve different purposes, a true assessment of total body fat is probably not particularly useful in the prediction of fitness, appearance, or health risks, except at extreme levels of obesity ("morbid" obesity) when other indicators would be obvious. Also, because fat in some female sites may be relatively uninfluenced by nutritional and exercise control, some excess fat in females probably does not reflect the poor self-discipline suggested by AR 600-9. In addition to these factors, the military occupational specialties which female soldiers are permitted to be assigned to generally have reduced physical requirements and these differences should be considered in establishing performance related fat standards.

Assessment of body fat in males is more reliable than in females. In this study, fat males decreased abdominal girth while the leanest males increased this measurement; this was reflected in their respective body fat changes and paralleled changes in weight. Males deposit excess fat primarily in the abdominal region (40,49) and this abdominal fat is readily mobilized in most men by exercise (50-51). Thus, excess girth serves as a suitable marker for overnutrition and underexercise, or in other words, indicates men who are less likely to be physically fit. Army studies of weight loss in males during basic training have repeatedly demonstrated that a decrease in this girth is a suitable

marker of increased fitness and appropriate nutrition (52-54). This site is the primary offender of military appearance in males (e.g. the "beer belly"), while fat which is better distributed is less noticeable than a "beer belly" and does not imply the same habits or carry the same health risks. Abdominal fat is the fat site most closely associated with reduced HDL-cholesterol (55) and is directly associated with an increased likelihood of coronary artery disease (56-58); this association between disease and waist girth was observed at least 50 years ago by the life insurance industry (59). Thus, it is both practical and accurate to assess fatness in normal males with a method which emphasizes an abdominal circumference. Although the current limits of fatness for males are more stringent than standards which would be set on the basis of health, they can be reasonably defended with physical performance data and on the basis of military appearance.

COMPARISON TO WEIGHT CONTROL GOALS AND STANDARDS OF THE NAVY

The U.S. Navy implemented a weight control program that differs significantly from the Army policy. All personnel in the Navy are assessed for body fat using circumference methods (60-61) every six months (OPNAVIST 6110.1D). This contrasts with the Army policy of biannual weigh-ins, after which only the overweight soldiers are assessed for body fat. If personnel exceed 26 (males) or 36% body fat (females) in three successive assessments, they may be separated from the Navy as weight control program failures. Before this final step is taken, they are further evaluated by a physician who certifies that they indeed qualify as morbidly obese, with supporting evidence such as hypertension and elevated serum cholesterol concentrations. These upper limits of fatness were translated from the recommendation of the Surgeon General of the Public Health Service (and the recommendation of the Defense Manpower Data Center) that people are considered to be overweight if their BMI exceeds the 85th percentile for young American adults, or approximately 120 percent of desirable weight (4).* An early screen of 22% and 30% for males and females, also regardless of age, gives Navy personnel an early warning of excess fatness and these individuals are placed on a weight control program to help them achieve fat loss.

The accession standards for the Navy are based on screening height-weight tables which approximate the 22% and 30%, male and female, body fat limits. Candidates exceeding these weight tables are assessed for body fat at the MEPS and are disqualified if they exceed the sex specific limits of 26% and 36% body fat.

These body fat standards are based on health rather than performance or appearance considerations. Evaluation of military appearance is left to efficiency reports and promotion boards and evaluation of physical performance is left to physical screening tests suited to Navy requirements. The female equation used by the Navy is highly appropriate to this purpose of a health standard since it assesses a waist girth (in addition to a hip circumference), the principal region of excess fat associated with increased health risks in men and women (38). Since the body fat limits are also reasonably liberal and because hip and waist circumferences are equally weighted in the equation, strong females with large upper body configurations ("apples") are not excluded unless they are very fat.

This approach to a weight control program is also in compliance with the DOD directive which initiated the use of body composition evaluations by all services. This highlights the wide range of military goals which are thought to be served by accession and retention physical standards. More specifically, the difference between the Army and the Navy approach demonstrates fundamental differences in the fitness requirements of the two services and in the way in which fitness is evaluated.

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* The NHANESII data yields a BMI standard of 27.2 kg/m^2 which equates to approximately 37% body fat for females predicted by regression (and extrapolation) from our recruit sample. This is essentially the Navy upper limit of 36% body fat.

CONCLUSIONS

Accepting that the accession standards should be linked to the retention standards based on achievable fat loss, it is also reasonable to suggest that the same system of evaluation should be used for both standards. Thus, a body fat standard along with an initial body weight screen should be used for accession as it is employed for retention. Using body fat instead of body weight as the ultimate accession standard will more effectively exclude male and female recruits who are not likely to meet retention standards after basic training. It will also preserve the accession of some suitable candidates who are overweight but are not overfat. Males up to 4% body fat units above the retention body fat standard can be expected to successfully lose enough weight to meet the standards within six months after graduation from basic training. However, until females are observed under similar circumstances (i.e. parallel standards producing similar motivation), it cannot be concluded that overfat females would not be as successful in maintaining a reduced body fat as the overfat males were in this study. It is apparent that a liberalization of female retention fat standards is needed, within the goals of the Army Weight Control Program. Ultimately, retention standards should be established from empirical data demonstrating that the method of fat estimation and that specific total or regional body fat standards do indeed optimize combat readiness and military appearance. Appropriate standards for males and females should not be linked and should be determined separately since the difference in male and female performance cannot be simply described by an interval of 8% body fat units.

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APPENDICES

APPENDIX A. Height-weight tables, AR 40-501, 1960.

Table I. Table of Militarily Acceptable Weight (in Pounds) as Related to Age and Height for Males—Initial Procurement

Height (inches)	Minimum (regardless of age)	Maximum					
		16-20 years	21-24 years	25-30 years	31-35 years	36-40 years	41 years and over
60	100	163	173	173	173	168	164
61	102	171	176	175	175	171	166
62	103	174	178	178	177	173	169
63	104	178	182	181	180	176	171
64	105	183	184	185	185	180	175
65	106	187	190	191	190	185	180
66	107	191	196	197	196	190	185
67	111	196	201	202	201	195	190
68	115	202	207	208	207	201	195
69	119	208	213	214	212	206	200
70	123	214	219	219	216	211	205
71	127	219	224	225	223	216	210
72	131	225	231	232	230	224	216
73	135	231	239	238	237	230	223
74	139	237	246	246	243	236	229
75	143	243	253	253	251	243	235
76	147	248	260	260	257	250	241
77	151	254	267	267	264	256	248
78	153	260	275	273	271	263	254

Table II. Table of Militarily Acceptable Weight (in Pounds) as Related to Age and Height for Females—Initial Procurement

Height (inches)	Minimum (regardless of age)	Maximum					
		16-20 years	21-24 years	25-30 years	31-35 years	36-40 years	41 years and over
58	90	135	137	140	138	135	135
59	93	137	139	144	140	139	138
60	96	139	141	147	142	142	141
61	99	141	144	150	144	145	141
62	102	144	147	154	147	148	147
63	105	150	152	157	152	151	150
64	109	152	155	160	155	155	154
65	112	155	160	164	161	159	158
66	115	160	165	168	166	164	163
67	119	163	168	173	171	168	167
68	122	169	175	177	176	172	171
69	125	175	178	182	180	176	175
70	128	181	184	186	185	181	180
71	131	186	190	191	190	185	184
72	135	191	194	195	194	189	188

APPENDIX B. Height-weight tables, AR 40-501, 1983.

Table 3-1
Military acceptable weight (in pounds) as related to age and height for males—Initial Army procurement

Height (inches)	Minimum weight (any age)	Maximum weight by years of age: 17-20	21-30	31-35	36-40	41 and over
60	100	158	163	162	157	150
61	102	163	168	167	162	155
62	103	168	174	173	166	160
63	104	174	180	178	173	165
64	105	179	185	184	179	171
65	106	185	191	190	184	176
66	107	191	197	196	190	182
67	111	197	203	202	196	187
68	115	203	209	208	202	193
69	119	209	215	214	208	198
70	123	215	222	220	214	204
71	127	221	228	227	220	210
72	131	227	234	233	226	216
73	135	233	241	240	233	222
74	139	240	248	246	238	228
76	143	246	254	253	246	234
76	147	253	261	260	252	241
77	151	260	268	266	259	247
78	155	267	276	273	266	254
79	159	273	282	281	273	260
80	166	280	289	288	279	267

Table 3-2
Military acceptable weight (in pounds) as related to age and height for females—Initial Army procurement

Height (inches)	Minimum weight (any age)	Maximum weight by years of age: 17-20	21-24	25-30	31-35	36-40	41 and over
58	90	120	124	126	129	132	135
59	92	122	126	128	131	134	137
60	94	124	128	130	133	136	139
61	96	127	130	132	135	139	141
62	98	130	132	134	137	140	144
63	100	132	134	136	139	143	145
64	102	135	138	138	143	145	149
65	104	138	140	144	146	150	153
66	106	141	145	148	151	154	157
67	109	145	149	152	156	158	162
68	112	150	153	156	160	162	166
69	115	154	157	161	164	167	170
70	118	158	162	165	168	171	174
71	121	162	166	169	172	175	178
72	125	167	171	174	178	181	184
73	129	171	177	178	183	186	190
74	133	175	182	183	188	191	195
75	133	179	187	190	194	196	200
76	136	184	192	195	199	202	205
77	139	188	197	201	204	207	211
78	141	193	203	206	209	213	216
79	144	198	208	211	215	219	222
80	147	201	213	216	219	223	226

WEIGHT TABLES FOR ARMY PERSONNEL

MALE (Regardless of Age)

Height (inches)	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Weight (pounds):																					
Minimum	100	102	103	104	105	106	107	111	115	119	123	127	131	135	139	143	147	151	153	159	166
Maximum	141	146	150	155	160	165	170	176	181	186	192	197	203	208	214	220	226	232	238	244	250

WOMEN (Regardless of Age)

Height (inches)	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
Weight (pounds):															
Minimum	90	92	94	96	98	100	102	104	106	109	112	115	118	122	125
Maximum	113	117	121	125	130	134	138	142	147	151	156	160	165	170	175

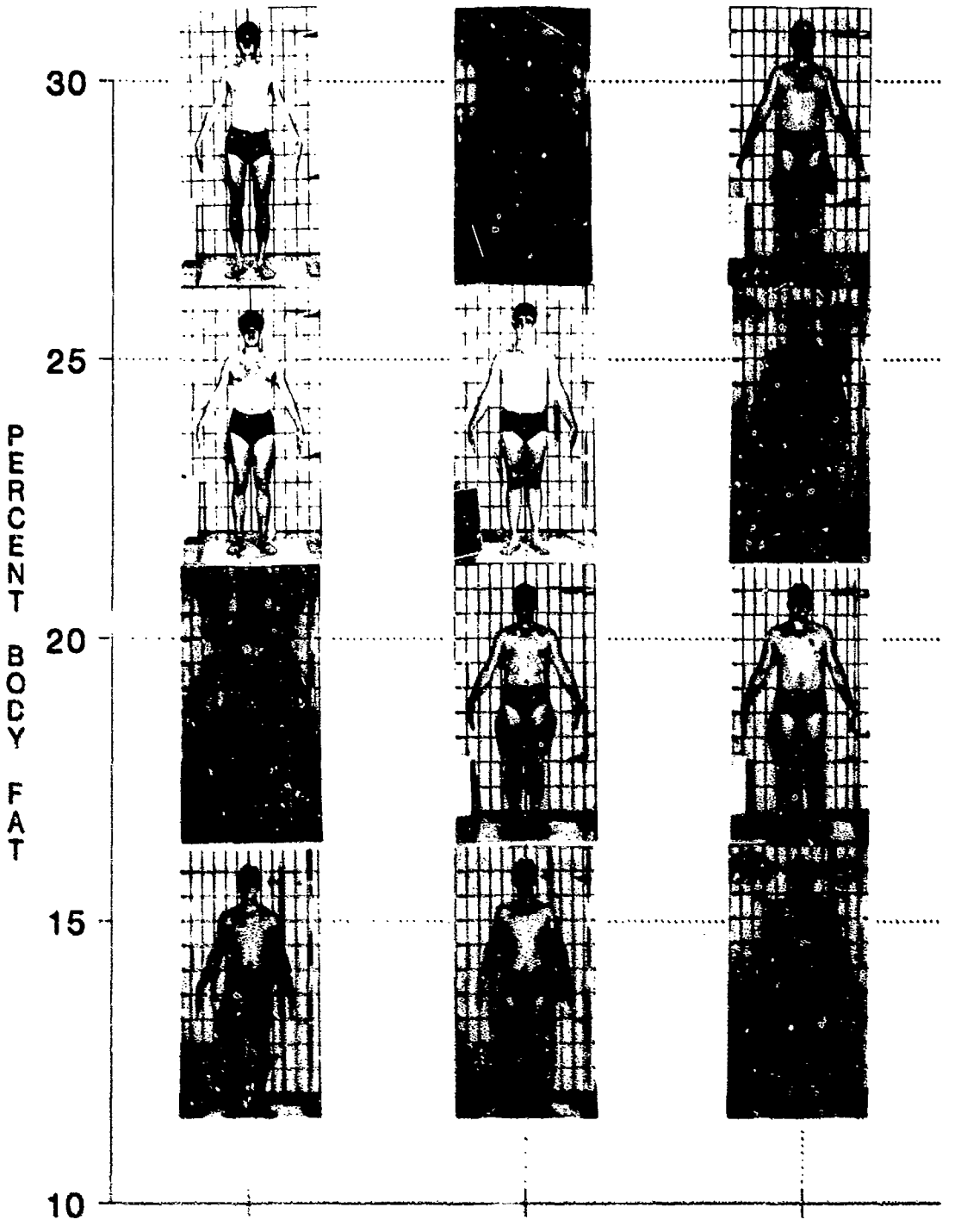
Note. Height and weight data do not include allowances for shoes and other clothing.

APPENDIX D. Height-weight & body fat standards and appearance.

Characteristics of the individuals in Figure 1 (page 11) are given below. This is constructed from Army Body Composition Study (1984) data based on 1125 male and 271 female soldiers. Some of this data has been published as a technical report on visual assessment of military appearance and fatness (the study also used side and rear views). The way in which a soldier wears their uniform is a significant component of military appearance. Fatness is more obvious for the same soldiers in swim trunks (next page).

Age
Height (inches)
Weight (pounds)
Percent fat, by underwater weighing

30 ---	26	19	20
% BODY	68.7 in	67.2 in	69.2 in
FAT	128 lbs	171 lbs	198 lbs
	29.4%	28.7%	28.0%
25 ---	20	19	21
	66.2 in	67.7 in	68.2 in
	142 lbs	171 lbs	196 lbs
	25.1%	26.5%	25.3%
20 ---	18	19	19
	69.4 in	68.2 in	68.1 in
	142 lbs	172 lbs	193 lbs
	19.9%	20.7%	19.6%
15 ---	20	20	21
	68.7 in	69.2 in	69.7 in
	143 lbs	168 lbs	194 lbs
	14.0%	16.1%	17.7%
	20% UNDER	RETENTION	ACCESSION
	BODY WEIGHT STANDARDS		


30
25
20
15
10
PERCENT BODY FAT
20% UNDER
RETENTION
ACCESSION
BODY WEIGHT STANDARDS

APPENDIX E. Instructions for body fat estimation, AR 600-9, 1987.

Standard Methods for Determining Body Fat Using Body Circumferences, Height and Weight

B-1. Introduction

a. The procedures for the measurements of height, weight, and specific body circumferences for the estimation of body fat are described in this appendix.

b. Although circumferences may be looked upon by untrained personnel as easy measures, they can give erroneous results if proper precautions are not followed. The individual taking the measurements must have a thorough understanding of the appropriate body landmarks and measurement techniques. Unit commanders should require that designated personnel have hands-on training and read the instructions regarding technique and location, and practice before official determinations are made. Two members of the unit should be utilized in the taking of measurements, one to place the tape measure and determine measurements, the other to assure proper placement and tension of the tape, as well as to record the measurement on the worksheet. The individual taking the measurements should be of the same sex as the soldier being measured; the individual who assists the measurer and does the recording may be of either sex. The two should work with the soldier between them so the tape is clearly visible from all sides. Measurements will be made three times, in accordance with standard body measurement procedures. This is necessary for reliability purposes, since the greater number of measurements, the lesser the standard of deviation. Also, if only two measurements were taken, there would be no way to tell which measurement was the most accurate. If there is greater than 1/4-inch difference between the measurements, then continue measuring until you have three measurements within 1/4-inch of each other. An average of the scores that are within 1/4-inch of each other will be used.

c. When measuring circumferences, compression of the soft tissue is a problem that requires constant attention. The tape will be applied so that it makes contact with the skin and conforms to the body surface being measured. It should not compress the underlying soft tissues. Note, however, that in the hip circumference more firm pressure is needed to compress gym shorts. All measurements are made in the horizontal plane, (i.e., parallel to the floor), unless indicated otherwise.

d. The tape measure should be made of a non-stretchable material, preferably fiberglass; cloth or steel tapes are unacceptable. Cloth measuring tapes will stretch with usage and most steel tapes do not conform to body surfaces. The tape measure should be calibrated, i.e., compared with a yardstick or a metal ruler to ensure validity. This is done by aligning the fiberglass tape measure with the quarter inch markings on the ruler. The markings should match those on the ruler; if not, do not use that tape measure. The tape should be 1/4- to 1/2-inch wide (not exceeding 1/2-inch) and a minimum of 5-6 feet in length. A retractable fiberglass tape is the best type for measuring all areas. Tapes currently available through the Army Supply System (Federal Stock Number 8315-00-782-3520) may exceed the 1/2-inch width limits and could slightly impact on circumferential measurements. Efforts are being made to replace the supply system tape with a narrower retractable tape. In the interim, the current Army supply system or any other fiberglass tape not to exceed 5/8-inch may be used if retractable tapes cannot be purchased by unit budget funds available and approved by installation commanders.

B-2. Height and weight measurements

a. The height will be measured with the soldier, in stocking feet (without shoes) and standard PT uniform, i.e., gym shorts and T-shirt, standing on a flat surface with the head held horizontal, looking directly forward with the line of vision horizontal, and the chin parallel to the floor. The body should be straight but not rigid, similar to the position of attention. Unlike the screening table weight this measurement will be recorded to the nearest 1/4-inch in order to gather a more accurate description of the soldier's physical characteristics.

b. The weight will be measured with the soldier in a standard PT uniform, i.e., gym shorts and a T-shirt. Shoes will not be worn. The measurement should be made on scales available in units and recorded to the nearest pound with the following guidelines:

(1) If the weight fraction of the soldier is less than 1/2-pound, round down to the nearest pound.

(2) If the weight fraction of the soldier is 1/2-pound or greater, round up to the next whole pound.

B–3. Description of circumference sites, and their anatomical landmarks and technique

a. All circumference measurements will be taken three times and recorded to the nearest 1/4-inch (or 0.25). Each sequential measurement should be within 1/4-inch of the next or previous measurement. If the measurements are within 1/4-inch of each other, derive a mathematical average to the nearest quarter (1/4) of an inch. If the measurements differ by 1/4-inch or more continue measurements until you obtain three measures within 1/4-inch of each other. Then average the three closest measures.

b. Each set of measurements will be completed sequentially to discourage assumption of repeated measurement readings. For males, complete 1 set of abdomen and neck measurements, NOT three abdomen circumferences followed by three neck circumferences. Continue the process by measuring the abdomen and neck in series until you have three sets of measurements. For females, complete one set of hip, forearm, neck, and wrist measurements, NOT 3 hip followed by three forearm etc. continue the process by measuring hip, forearm, neck, and wrist series until you have 3 sets of measurements.

c. Worksheets for computing body fat are at figure B–1 (males) and figure B–3 (females). Local reproduction is authorized. A blank copy of DA Forms 5500–R and 5501–R is located at the back of this volume. These forms will be reproduced locally on 8½ x 11-inch paper. Supporting factor tables are located at tables B–1 and B–2 (males) and tables B–3 through B–8 (females) and include specific steps for preparing body fat content worksheets.

d. Illustrations of each tape measurement are at figure B–2 (males) and figure B–4 (females). A training videotape (TVT 8–103) is also available at Visual Information Libraries, and/or Training Audiovisual Support Centers (TASC).

B–4. Circumference sites and landmarks for males

a. Abdomen. The soldier being measured will be standing with arms relaxed. The abdominal measurement is taken at a level coinciding with the midpoint of the navel (belly button) with the tape placed so that it is level all the way around the soldier being measured. Record the measurement at the end of a normal expiration. It is important that the soldier does not attempt to hold his abdomen in, thus resulting in a smaller measurement. Also the tape must be kept level across the abdomen and back.

b. Neck. The soldier being measured will be standing, looking straight ahead, chin parallel to the floor. The measurement is taken by placing the tape around the neck at a level just below the larynx (Adam's apple). Do not place the tape measure over the Adam's apple. The tape will be as close to horizontal (the tape line in the front of the neck should be at the same height as the tape line in the back of the neck) as anatomically feasible. In many cases the tape will slant down toward the front of the neck. Therefore, care should be taken so as not to involve the shoulder/neck muscles (trapezius) in the measurement. This is a possibility when a soldier has a short neck.

B–5. Circumference sites and landmarks for females

a. Neck. This procedure is the same as for males.

b. Forearm. The soldier being measured will be standing with the arm extended away from the body so that the forearm is in plain view of the measurer, with the hand palm up. The soldier should be allowed to choose which arm he/she prefers to be measured. Place the tape around the largest forearm circumference. This will be just below the elbow. To ensure that this is truly the largest circumference, since it is being visually identified, slide the tape along the forearm to find the largest circumference.

c. Wrist. The soldier being measured will stand with the arm extended away from the body so that the wrist is in plain view of the measurer. The tape will be placed around the wrist at a point above the hand just below the lower end of the bones of the forearm.

d. Hip. The soldier taking the measurement will view the person being measured from the side. Place the tape around the hips so that it passes over the greatest protrusion of the gluteal muscles (buttocks) keeping the tape in a horizontal plane (i.e., parallel to the floor). Check front to back and side to side to be sure the tape is level to the floor on all sides before the measurements are recorded. Since the soldier will be wearing gym shorts, the tape can be drawn snugly to minimize the influence of the shorts on the size of the measurement

B–6. Preparation of the body fat content worksheets

NOTE: IT IS EXTREMELY IMPORTANT THAT YOU READ ALL OF THESE INSTRUCTIONS BEFORE ATTEMPTING TO COMPLETE THE BODY FAT CONTENT WORKSHEETS. MAKE SURE THAT YOU HAVE A COPY OF THE WORKSHEET IN FRONT OF YOU WHEN YOU ARE READING THESE INSTRUCTIONS.

a. The following paragraphs will provide information needed to prepare the Body Fat Content Worksheets for males and females, DA Form 5500–R and 5501–R, Dec 85. The worksheets are written in a stepwise fashion. The measurements and computation processes are different for males and females.

b. You will be responsible for completing a worksheet for soldiers who exceed the screening table weight (Table 1) located in this regulation, or when a unit commander or supervisor determines that the individual's appearance suggests that body fat is excessive (para 20*a* AR 600–9). The purpose of this form is to help you determine the soldier's percent body fat using the circumference technique described in this regulation.

c. Before you start, you should have a thorough understanding of the measurements to be made as outlined in this appendix. You will also need a scale for measuring body weight, a height measuring device, and a measuring tape (see specifications in para B–1*d*) for the circumference measurements.

Table B–4
Female Height Factor

Inches	0.00	.25 (¼)	.50 (½)	.75 (¾)
55	71.97	72.30	72.62	72.95
56	73.28	73.61	73.93	74.26
57	74.59	74.91	75.24	75.57
58	75.90	76.22	76.55	76.88
59	77.20	77.53	77.86	78.19
60	78.51	78.84	79.17	79.49
61	79.82	80.15	80.48	80.80
62	81.13	81.46	81.78	82.11
63	82.44	82.77	83.09	83.42
64	83.75	84.07	84.40	84.73
65	85.06	85.38	85.71	86.04
66	86.36	86.69	87.02	87.35
67	87.67	88.00	88.33	88.65
68	88.98	89.31	89.64	89.96
69	90.29	90.62	90.94	91.27
70	91.60	91.93	92.25	92.58
71	92.91	93.23	93.56	93.89
72	94.22	94.54	94.87	95.20
73	95.52	95.85	96.18	96.51
74	96.83	97.16	97.49	97.81
75	98.14	98.47	98.80	99.12
76	99.45	99.78	100.10	100.43
77	100.76	101.09	101.41	101.74
78	102.07	102.39	102.72	103.05
79	103.38	103.70	104.03	104.36
80	104.68	105.01	105.34	105.67
81	105.99	106.32	106.65	106.97
82	107.30	107.63	107.96	108.28
83	108.61	108.94	109.26	109.59
84	109.92	110.24	110.57	110.90

Table B–5
Female Hip Factor

Inches	0.00	.25 (¼)	.50 (½)	.75 (¾)
30	13.19	13.30	13.41	13.52
31	13.63	13.74	13.85	13.96
32	14.07	14.18	14.29	14.40
33	14.51	14.62	14.73	14.84
34	14.95	15.06	15.17	15.28
35	15.39	15.50	15.61	15.72
36	15.83	15.94	16.05	16.15
37	16.26	16.37	16.48	16.59
38	16.70	16.81	16.92	17.03
39	17.14	17.25	17.36	17.47
40	17.58	17.69	17.80	17.91
41	18.02	18.13	18.24	18.35
42	18.46	18.57	18.68	18.79
43	18.90	19.01	19.12	19.23
44	19.34	19.45	19.56	19.67
45	19.78	19.89	20.00	20.11
46	20.22	20.33	20.44	20.55
47	20.66	20.77	20.88	20.99
48	21.10	21.21	21.32	21.43
49	21.54	21.65	21.76	21.87
50	21.98	22.09	22.20	22.31
51	22.42	22.53	22.64	22.75
52	22.86	22.97	23.08	23.19
53	23.30	23.41	23.52	23.63

Table B–6
Female Forearm Factor

Inches	0.00	.25 (¼)	.50 (½)	.75 (¾)
5	19.98	20.98	21.98	22.98
6	23.98	24.98	25.98	26.98
7	27.96	28.96	29.96	30.97
8	31.97	32.97	33.97	34.97
9	35.97	36.97	37.97	38.97
10	39.97	40.97	41.97	42.97
11	43.96	44.96	45.96	46.96
12	47.96	48.96	49.96	50.96
13	51.95	52.96	53.96	54.96
14	55.95	56.95	57.95	58.95
15	59.95	60.95	61.95	62.95

Table B–7
Female Neck Factor

Inches	0.00	.25 (¼)	.50 (½)	.75 (¾)
5	6.77	7.11	7.45	7.79
6	8.12	8.46	8.80	9.14
7	9.48	9.82	10.16	10.49
8	10.83	11.17	11.51	11.85
9	12.19	12.53	12.86	13.20
10	13.54	13.88	14.22	14.56
11	14.90	15.23	15.57	15.91
12	16.25	16.59	16.93	17.26
13	17.60	17.94	18.28	18.62
14	18.96	19.30	19.63	19.97
15	20.31	20.65	20.99	21.33

Table B–8
Female Wrist Factor

Inches	0.00	.25 (¼)	.50 (½)	.75 (¾)
5	2.54	2.67	2.80	2.93
6	3.05	3.18	3.31	3.43
7	3.56	3.69	3.82	3.94
8	4.07	4.20	4.33	4.45
9	4.58	4.71	4.83	4.96
10	5.09	5.22	5.34	5.47
11	5.60	5.72	5.85	5.98
12	6.11	6.23	6.36	6.49
13	6.62	6.74	6.87	7.00
14	7.12	7.25	7.38	7.51
15	7.63	7.76	7.89	8.01

B-7. Steps for preparing the Male Body Fat Content Worksheet, DA Form 5500-R, Dec 85

Name Print the soldier's last name, first name, and middle initial in the NAME block. Also include his Rank and Social Security Number.

Age Print his age in years in the AGE block.

Height Measure the soldier's height as described in the appendix, to the nearest quarter of an inch, and record the measurement in the HEIGHT block.

Weight Measure the soldier's weight as described in this appendix, to the nearest pound, and record in the WEIGHT block.

Note. Follow the rules for rounding of height and weight measurements as described earlier in the appendix.

Step 1. Abdominal Measurement
Measure the soldier's abdominal circumference to the nearest quarter of an inch, and record in the block labeled "FIRST."

Step 2. Neck Measurement
Measure the soldier's neck circumference to the nearest quarter of an inch, and record in the block labeled "FIRST."

Note. REPEAT STEPS 1 and 2, in series until you have completed three sets of abdomen and neck circumferences.

Step 3. Average Abdominal Measurement
Find the mathematical average of the FIRST, SECOND, and THIRD abdominal circumferences by adding them together and dividing by three. Place the number to the nearest quarter of an inch, in the block marked AVERAGE, for STEPS 1 and 3.

Step 4. Average Neck Measurement
Find the mathematical average of your FIRST, SECOND, and THIRD neck circumferences by adding them together and dividing by three. Place this number to the nearest quarter of an inch in the block marked AVERAGE, for STEPS 2 and 4.

Step 5. Abdomen-Neck Difference
Subtract the number found in the AVERAGE block of STEP 4 from the number found in the AVERAGE block in STEP 3. Enter the result in STEP 5. This is the difference between the abdomen and neck circumferences.

Step 6. Abdomen-Neck Factor
Go to Table B-1, the Abdomen-Neck Factor Table, and locate the abdomen-neck difference in the left-most column. If the difference is a whole number, i.e., 15 inches, the Abdomen-Neck Factor is 89.93. If the difference is 15.25 inches, the factor would be 90.48. If the difference is 15.50, the factor is 91.02, and if the difference is 15.75, the factor is 91.55. Enter the appropriate factor in STEP 6.

Step 7. Height Factor
Go to Table B-2, the Height Factor Table, and locate the soldier's height in the left-most column. If the height is a whole number, i.e., 64 inches, the factor is 77.15. If the height is not a whole number, i.e., 64.25 inches, the factor is 77.27. If the height is 64.50 inches the factor is 77.39, and if the height is .75 inches, the factor is 77.50. Enter the appropriate factor in STEP 7.

Note. Therefore, the general rule for the factor tables is if the measure or difference is a whole number your factor will be located under the 0.00 column directly across from the inches column. Columns .25, .50, .75 correspond to measurements that are not whole numbers, but rather are fractions of an inch.

Step 8. Percent Body Fat
Subtract the number found in the AVERAGE block of STEP 7 from the number found in the AVERAGE block of STEP 6 and enter the difference in STEP 8. This is the soldier's PERCENT BODY FAT.

Table B-1
Male Abdomen and Neck Factor

Difference in Inches	0.00	.25 (¼)	.50 (½)	.75 (¾)
5	53.44	55.06	56.61	58.09
6	59.50	60.85	62.16	63.41
7	64.62	65.78	66.91	68.00
8	69.05	70.07	71.07	72.03
9	72.96	73.87	74.76	75.62
10	76.48	77.28	78.08	78.86
11	79.63	80.37	81.10	81.82
12	82.52	83.20	83.87	84.53
13	85.17	85.81	86.43	87.04
14	87.64	88.22	88.80	89.37
15	89.93	90.48	91.02	91.55
16	92.07	92.58	93.09	93.59
17	94.08	94.57	95.05	95.52
18	95.98	96.44	96.89	97.34
19	97.78	98.21	98.64	99.06
20	99.48	99.89	100.30	100.70
21	101.10	101.48	101.86	102.26
22	102.64	103.02	103.39	103.76
23	104.12	104.48	104.83	105.18
24	105.53	105.88	106.22	106.56
25	106.89	107.22	107.55	107.87
26	108.19	108.51	108.82	109.14
27	109.44	109.75	110.06	110.35
28	110.65	110.96	111.24	111.53
29	111.82	112.10	112.38	112.67
30	112.94	113.22	113.49	113.76
31	114.03	114.30	114.56	114.83
32	115.09	115.35	115.60	115.86
33	116.11	116.36	116.61	116.85
34	117.10	117.34	117.58	117.82
35	118.06	118.30	118.53	118.77
36	119.00	119.23	119.46	119.68
37	119.91	120.13	120.36	120.57
38	120.79	121.01	121.23	121.44
39	121.66	121.87	122.08	122.29
40	122.50	122.70	122.91	123.11

Table B-2
Male Height Factor

Inches	0.00	.25 (¼)	.50 (½)	.75 (¾)
60	75.23	75.35	75.48	75.60
61	75.72	75.84	75.96	76.09
62	76.21	76.32	76.45	76.56
63	76.68	76.80	76.92	77.04
64	77.15	77.27	77.39	77.50
65	77.62	77.73	77.84	77.96
66	78.07	78.18	78.30	78.41
67	78.52	78.63	78.74	78.85
68	78.96	79.07	79.18	79.29
69	79.40	79.50	79.61	79.72
70	79.83	79.93	80.04	80.14
71	80.25	80.35	80.46	80.56
72	80.67	80.77	80.87	80.98
73	81.08	81.18	81.28	81.38
74	81.48	81.58	81.68	81.78
75	81.88	81.98	82.08	82.18
76	82.28	82.38	82.47	82.57
77	82.67	82.77	82.86	82.96
78	83.05	83.15	83.24	83.34
79	83.43	83.53	83.62	83.72
80	83.81	83.90	83.99	84.09
81	84.18	84.27	84.36	84.45
82	84.54	84.64	84.73	84.82
83	84.91	85.00	85.08	85.17
84	85.26	85.35	85.44	85.53

BODY FAT CONTENT WORKSHEET (Male)

DOE JOHN		198-00-0000		SGT	
72		175		21	
		FIRST	SECOND	THIRD	AVERAGE
1		36.25	36.50	36.25	36.25
2		16.25	16.25	16.50	16.25
3					36.25
4					16.25
5					20.00
6					99.48
7					80.67
8					18.81

Figure 5-1. Example of a completed DA Form 5500

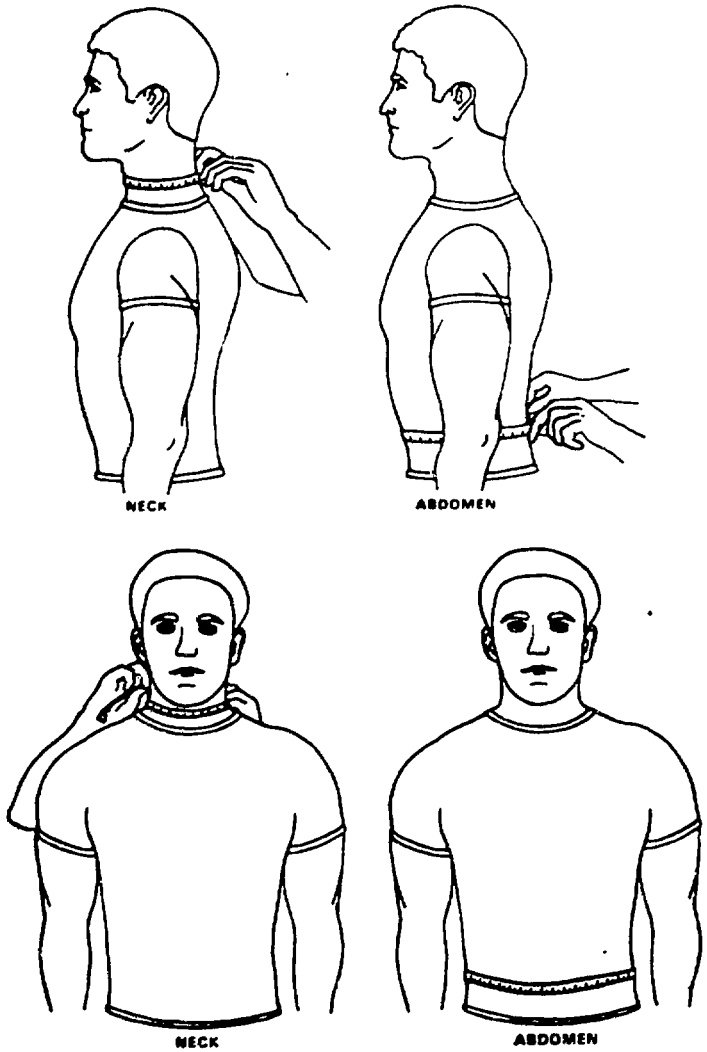


Figure 5-2. Male Measurement

B–6. Steps for preparing the Female Body Fat Content Worksheet, DA Form 5501–R, Dec 85

Name Print the soldier's last name, and middle initial in the NAME block. Also include her Rank, and Social Security Number

Age Print her age in years in the AGE block.

Height Measure the soldier's height as described in this appendix, to the nearest quarter of an inch, and record the measurement in the HEIGHT block

Weight Measure the soldier's weight as described in this appendix, to the nearest pound, and record in the WEIGHT block.

Note Follow the rounding rules for rounding height and weight measurements as described earlier in this appendix

Step 1. Weight Factor

Go to Table B–3, the Weight Factor Table, and locate the soldier's weight in the left-most column, which is in 10 pound increments. If the weight is exactly 120 pounds, the factor is found under the "0" column and is 147.24. If the weight is 121 pounds, the factor is found under the "1" column and is 147.62. If the weight is 126 the factor is found under the "6" column and is 149.47. Enter the appropriate weight factor in the CALCULATIONS section, STEP 11 A.

Step 2. Height Factor

Go to Table B–4, the Height Factor Table, and locate the soldier's height in the left-most column. If the height is a whole number, i.e., 64 inches, the factor is found under the 0.00 column and is 83.75. If the height is not a whole number, i.e., 64.25 inches, the factor is 84.07. If the height is 64.50 inches, the factor is 84.40, and if the height is 64.75 inches, the factor is 84.73. Enter the appropriate height factor in the CALCULATIONS section, STEP 11 D

Step 3. Hip Measurement

Measure the soldier's hip circumference to the nearest quarter of an inch, and record in the block labeled "FIRST."

Step 4. Forearm Measurement

Measure the soldier's forearm to the nearest quarter of an inch, and record in the block labeled "FIRST."

Step 5. Neck Measurement

Measure the soldier's neck circumference to the nearest quarter of an inch, and record in the block labeled "FIRST."

Step 6. Wrist Measurement

Measure the soldier's wrist to the nearest quarter of an inch, and record in the block labeled "FIRST."

Note REPEAT STEPS 3, 4, 5, and 6, IN SERIES, until you have completed 3 sets of Hip, Forearm, Neck and Wrist circumferences. When you have completed this series, find the mathematical average for each of the 4 circumference measures and place each average in its respective AVERAGE block.

Step 7. Hip Factor

Go to Table B–5, the Hip Factor Table, and locate the soldier's AVERAGE hip circumference in the left-most column. If the circumference is a whole number, i.e., 36 inches, the Hip Factor is found in the 0.00 column and is 15.83. If the circumference is not a whole number but is 36.25 inches, the factor is 15.84. If the circumference is 36.50 the factor is 16.05. Enter the appropriate factor in the CALCULATIONS section, 11 B.

Step 8. Forearm Factor

Go to Table B–6, the Forearm Factor Table, and locate the soldier's AVERAGE forearm circumference in the left-most column. If the circumference is a whole number, i.e., 10 inches, the factor is found under 0.00 column and is 38.97. If the circumference is not a whole number but is 10.25 inches, the factor is 40.97. If the circumference is 10.75 inches, the factor is 40.97. Enter the appropriate factor in the CALCULATIONS, 11 E.

Step 9. Neck Factor

Go to Table B–7, the Neck Factor Table, and locate the soldier's AVERAGE neck circumference in the left-most column. If the circumference is a whole number, i.e., 12 inches, the factor is found under the 0.00 column and is 16.25. If the circumference is not a whole number but is 12.25 inches, the factor is 16.59. If the circumference is 12.50 inches, the factor is 16.93. If the circumference is 12.75 inches, the factor is 17.26. Enter the appropriate factor is the CALCULATIONS section, 11 F

Step 10. Wrist Factor

Go to Table B–8, the Wrist Factor Table, and locate the soldier's AVERAGE wrist circumference in the left-most column. If the circumference is a whole number, i.e., 7 inches, the factor is found under the 0.00 column and is 3.58. If the circumference is not a whole number but is 7.25 inches, the factor is 3.69. If the circumference is 7.50 inches, the factor is 3.82. If the circumference is 7.75 inches, the factor is 3.94. Enter the appropriate factor in the CALCULATIONS section, 11 G.

Calculations

Line C. Addition of Weight and Hip Factors

Add 11 A, Weight Factor, to 11 B, Hip Factor. Enter the result on line 11 C (Total).

Line H. Addition of Height, Forearm, Neck, and Wrist Factors

Add 11 D, Height Factor, 11 E, Forearm Factor, 11 F, Neck Factor, and 11 G, Wrist Factor together. Enter the result on the 11 H (Total)

Line I. Percent Body Fat

Subtract Line 11–H from Line–C and enter on Line I. This is the soldier's PERCENT BODY FAT

Table B–3
Female Weight Factor

Pounds	0	1	2	3	4	5	6	7	8	9
90	134.08	134.58	136.08	135.58	136.07	136.55	137.03	137.50	137.97	138.44
100	138.90	139.35	139.80	140.25	140.69	141.13	141.56	141.99	142.42	142.84
110	143.26	143.67	144.08	144.49	144.89	145.29	145.68	146.08	146.47	146.85
120	147.24	147.62	147.99	148.37	148.74	149.10	149.47	149.83	150.19	150.54
130	150.90	151.25	151.60	151.94	152.28	152.62	152.96	153.30	153.63	153.96
140	154.29	154.61	154.94	155.26	155.58	155.89	156.21	156.52	156.83	157.14
150	157.44	157.75	158.05	158.35	158.65	158.94	159.24	159.53	159.82	160.11
160	160.40	160.68	160.96	161.25	161.53	161.80	162.08	162.35	162.63	162.90
170	163.17	163.44	163.70	163.97	164.23	164.49	164.76	165.01	165.27	165.53
180	165.78	166.04	166.29	166.54	166.79	167.04	167.29	167.53	167.77	168.02
190	168.25	168.50	168.74	168.97	169.21	169.44	169.68	169.91	170.14	170.37
200	170.60	170.83	171.06	171.29	171.51	171.73	171.96	172.18	172.40	172.62
210	172.83	173.05	173.27	173.48	173.70	173.91	174.12	174.33	174.54	174.75
220	174.96	175.20	175.41	175.61	175.82	176.02	176.22	176.42	176.62	176.82
230	177.03	177.22	177.42	177.62	177.81	178.00	178.20	178.40	178.59	178.82
240	178.97	179.16	179.35	179.54	179.73	179.92	180.10	180.29	180.47	180.66
250	180.84	181.02	181.20	181.39	181.57	181.75	181.92	182.10	182.28	182.46
260	182.63	182.81	182.98	183.16	183.33	183.51	183.68	183.85	184.02	184.19
270	184.36	184.53	184.70	184.87	185.03	185.20	185.37	185.53	185.70	185.86

BODY FAT CONTENT WORKSHEET *(Female)*

DOE JANE	492-00-0000		SGT	
63.00	132		21	
STEP		MEASURE		AVERAGE
3 Measure hips at most protruding point	29 75	30.00	30.25	30 00
4 Measure forearm at its largest point	8 25	8 50	8.75	8 50
5 Measure neck just below larynx	13 25	13 50	13.75	13.50
6 Measure wrist between the bones	5 75	6.00	6 25	6.00

11 CALCULATIONS		
A	131 60	
B	13.19	
C TOTAL		164 79
D	82 54	
E	38.97	
F	18.24	
G	5.05	
H TOTAL		137 74
I SOLDIER'S PERCENT BODY FAT		27.05

DA FORM 5501-R, DEC 45

Figure B-5. Example of a completed DA Form 5501

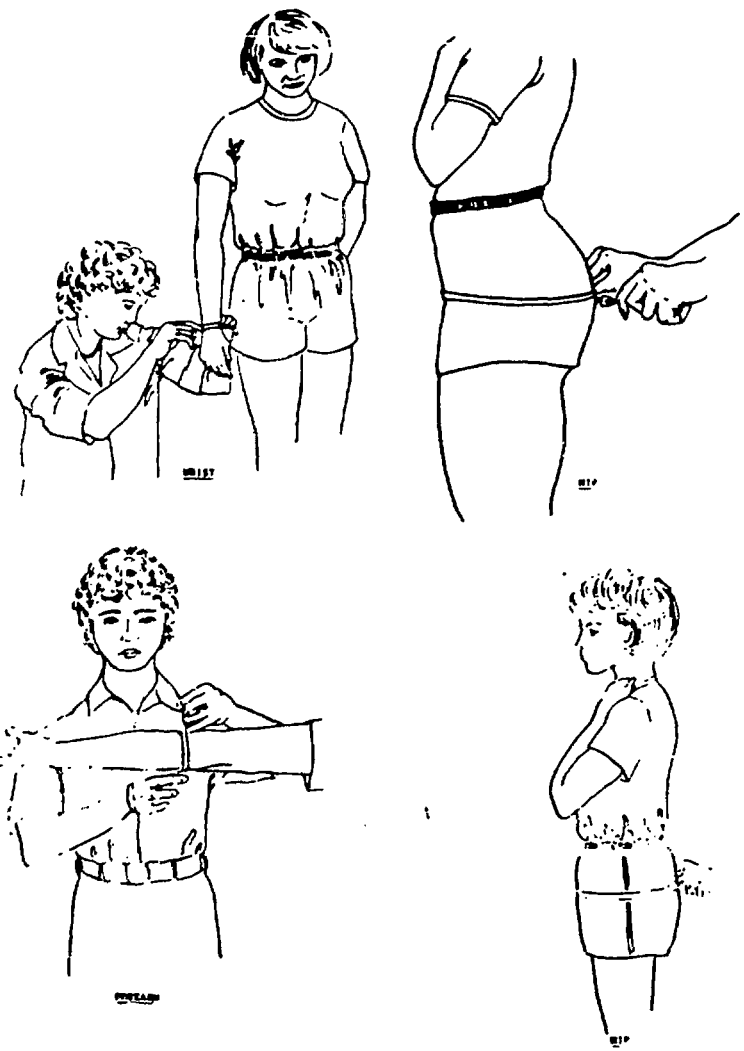


Figure B-4. Female Measurement

Weight for Height Table (Screening Table Weight)

Height (in inches)	MALE				FEMALE			
	Age				Age			
	17–20	21–27	28–39	40+	17–20	21–27	28–39	40+
58	—	—	—	—	104	107	110	113
59	—	—	—	—	107	110	114	117
60	132	136	139	141	111	114	117	121
61	136	140	144	146	115	118	121	125
62	141	144	148	150	119	123	126	130
63	145	149	153	155	123	126	130	134
64	150	154	158	160	126	130	134	138
65	155	159	163	165	130	134	138	142
66	160	163	168	170	135	139	143	147
67	165	169	174	176	139	143	148	151
68	170	174	179	181	143	147	151	156
69	175	179	184	186	147	151	155	160
70	180	185	189	192	151	156	160	165
71	185	189	194	197	155	159	164	169
72	190	195	200	203	160	164	169	174
73	195	200	205	208	165	169	174	179
74	201	206	211	214	170	174	180	185
75	206	212	217	220	175	179	184	190
76	212	217	223	226	180	185	190	196
77	218	223	229	232	184	190	195	201
78	223	229	235	238	189	194	200	206
79	229	235	241	244	194	199	205	211
80	234	240	247	250	198	204	210	216

Table 1
Weight for Height Table (Screening Table Weight)

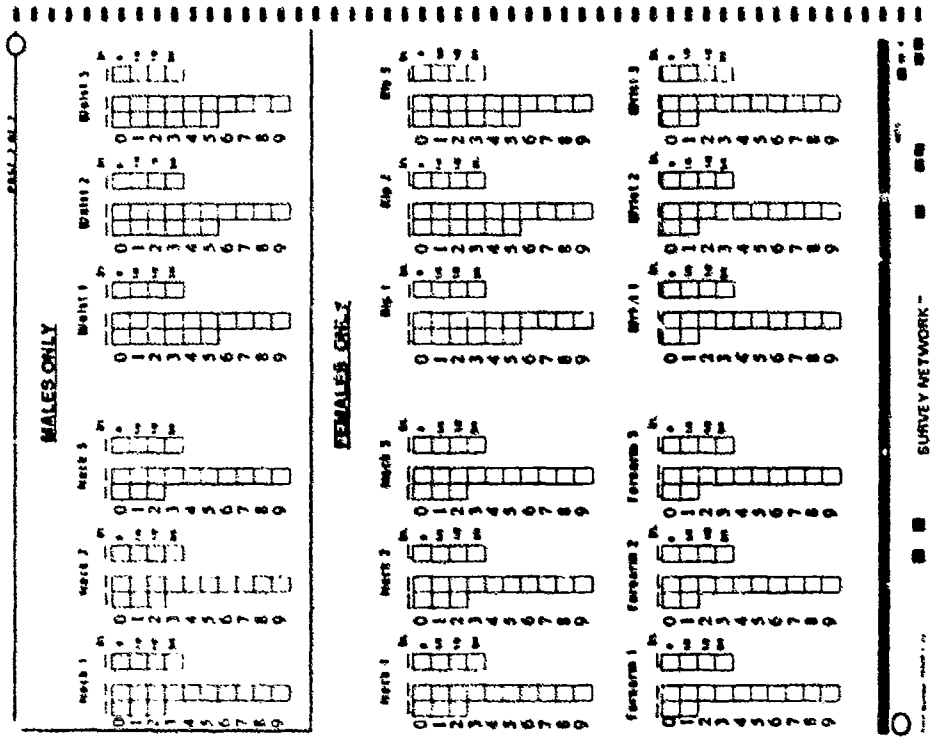
Height (in inches)	Male Age				Female Age			
	17–20	21–27	28–39	40+	17–20	21–27	28–39	40+
58	—	—	—	—	109	112	115	119
59	—	—	—	—	113	116	119	123
60	132	136	139	141	116	120	123	127
61	136	140	144	146	120	124	127	131
62	141	144	148	150	125	129	132	137
63	145	149	153	155	129	133	137	141
64	150	154	158	160	133	137	141	145
65	155	159	163	165	137	141	145	149
66	160	163	168	170	141	146	150	154
67	165	169	174	176	145	149	154	159
68	170	174	179	181	150	154	159	164
69	175	179	184	186	154	158	163	168
70	180	185	189	192	159	163	168	173
71	185	189	194	197	163	167	172	177
72	190	195	200	203	167	172	177	183
73	195	200	205	208	172	177	182	188
74	201	206	211	214	178	183	189	194
75	206	212	217	220	183	188	194	200
76	212	217	223	226	189	194	200	206
77	218	223	229	232	193	199	205	211
78	223	229	235	238	198	204	210	216
79	229	235	241	244	203	209	215	222
80	234	240	247	250	208	214	220	227

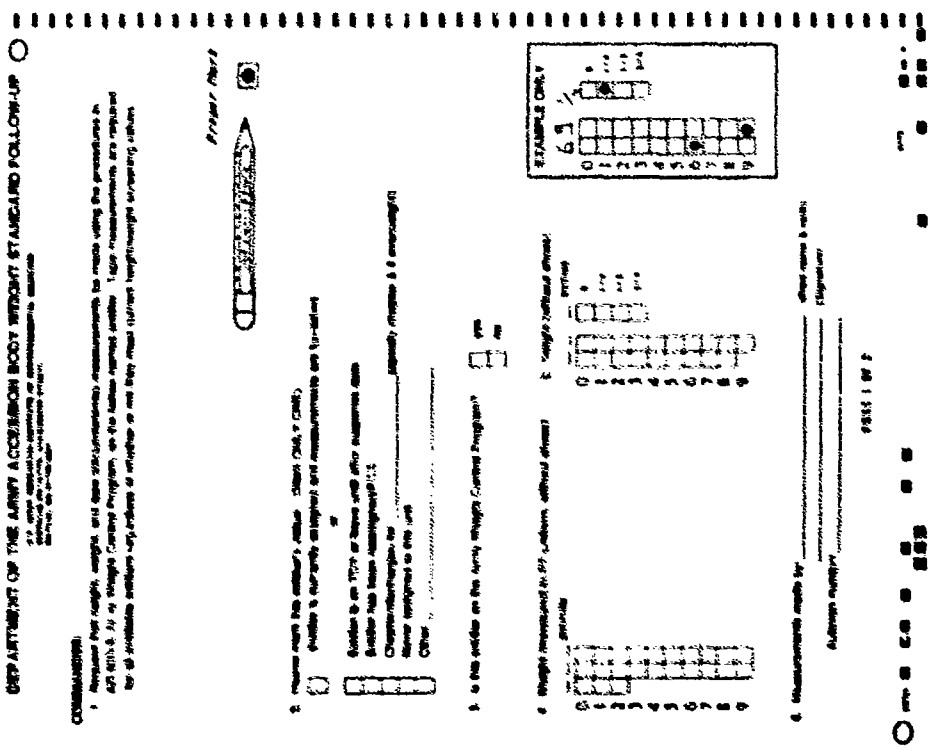
Notes:
1. The height will be measured in stocking feet (without shoes), standing on a flat surface with the chin parallel to the floor. The body should be straight but not rigid, similar to the position of attention. The measurement will be rounded to the nearest inch with the following guidelines:
   a. If the height fraction is less than 1/2 inch, round down to the nearest whole number in inches.
   b. If the height fraction is 1/2 inch or greater, round up to the next highest whole number in inches.
2. The weight should be measured and recorded to the nearest pound within the following guidelines.
   a. If the weight fraction is less than 1/2 pound, round down to the nearest pound.
   b. If the weight fraction is 1/2 pound or greater, round up to the next highest pound.
3. All measurements will be in a standard PT uniform (gym shorts and T-shirt, without shoes).
4. If the circumstances preclude weighing soldiers during the APFT, they should be weighed within 30 days of the APFT.
5. Add 6 pounds per inch for males over 80 inches and 5 pounds for females for each inch over 80 inches.

APPENDIX H. Military units and number of soldiers studied. "Complete data" indicates subjects measured by the study team, "unit data" indicates subjects for which some data was obtained, including some not measured by the study team, "total in unit" indicates number of soldiers in the training unit.

Unit	complete data (#soldiers)	unit data & total in unit (#soldiers)	Dates of training start	end
Male recruit				
Co A, 1-34	96	219/248	23 Sept	17 Nov
Co B, 1-34	189	189/225	21 Sept	17 Nov
Co C, 1-34	227	227/231	22 Sept	17 Nov
Co A, 2-13	203	219/219	7 Oct	1 Dec
Co B, 2-13	164	225/225	28 Sep	22 Nov
Co C, 2-13	53	215/215	1 Oct	22 Nov
Co B, protrain	55	121/121	13 Oct	8 Dec
Co C, protrain	61	116/116	14 Oct	8 Dec
Total	1048	1531/1600		
Female recruits				
Co B, 1-28	136	209/209	16 Sep	9 Nov
Co D, 1-34	188	204/204	23 Sept	17 Nov
Co E, 2-13	190	210/214	30 Sept	22 Nov
Co D, 2-13	200	213/228	7 Oct	1 Dec
Co D, 3-34	46	156/184	7 Oct	1 Dec
Co E, protrain	86	100/100	15 Oct	8 Dec
Total	846	1092/1139		

APPENDIX I. Survey Instrument and cover letters.





DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR PERSONNEL
WASHINGTON, DC 20310-0300

REPLY TO ATTENTION OF

DAPE-MPA

S: 25 Aug 89
1 Aug 89

MEMORANDUM FOR COMMANDERS

SUBJECT: Study of Army Accession Height and Weight Standards

1. There is concern among the leadership of the Army that the height and weight standards we require our new soldiers to meet upon initial entry are in proper relationship to the requirements for retention UP AR 600-9, The Army Weight Control Program. As you know, some of our soldiers experience difficulties in this regard.

2. To gain more information in this area, the US Army Institute for Environmental Medicine (USARIEM) has been conducting a study during which they obtained data from a sizable sample of the trainee population at Fort Jackson, SC. These trainees have now moved to their first units and follow-up data collection is necessary to validate previous statistical analyses.

3. Your help is needed to complete this important effort and I ask that you have the enclosed information forms completed for the study participants currently in your command. If the forms cannot be completed, please mark the appropriate reason and return them expeditiously in the enclosed pre-addressed envelope. If you have questions concerning this study, you may address them to the study project officers at USARIEM, LTC Bruce Jones or CPT Karl Friedl, at AUTOVON 256-4847. Your assistance is appreciated.

FOR THE DEPUTY CHIEF OF STAFF FOR PERSONNEL:

Enclosures

Myrna H. Williamson
MYRNA H. WILLIAMSON
Brigadier General, GS
Deputy Director of Military
Personnel Management

82

DEPARTMENT OF THE ARMY
US ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE
NATICK, MASSACHUSETTS 01760-5007

SGRD-UE-PH

15 Sept 89

MEMORANDUM FOR COMMANDERS

SUBJECT: 2nd Request for Soldier Height, Weight & Circumferences

1. You were previously requested by Brigadier General Williamson (ODSCPER) to complete and return a survey for the Army Accession Weight Standards Study. The suspense for this action was 25 August 1989. I have not recorded a return from you. PLEASE COMPLETE THE ATTACHED FORM FOR THE NAMED SOLDIER AND RETURN ASAP.

2. The purpose of this study is to determine the suitability of current accession height-weight standards. The requested information is to provide followup on a series of soldiers who were studied in basic training at Fort Jackson at the end of last year. This data is for research purposes and this information will be reported as summaries of the 2600 studied individuals. In other words, it will not affect the individual's career.

3. If the soldier is not available for the requested measurements please return the form anyway, adding any available information in block 2. We must identify reasons for any missing individuals.

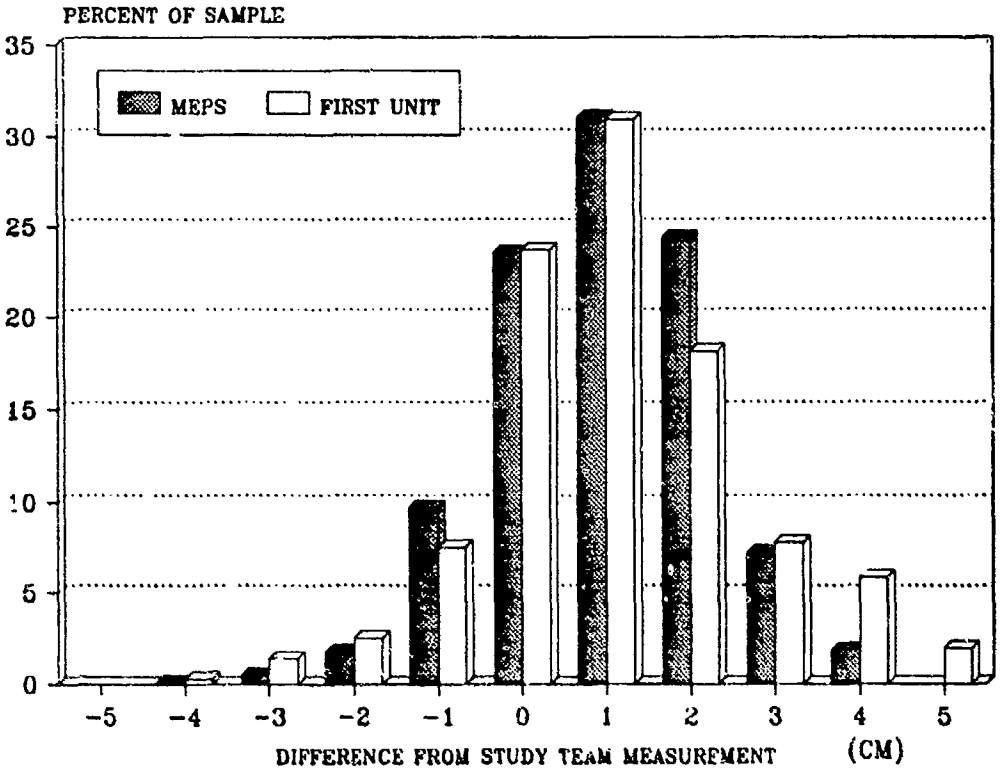
4. Please identify female soldiers who are pregnant under "other" and do not complete measurements on those soldiers.

5. If you have any questions concerning this survey or cannot return it immediately, please phone me at AV 256-4847 (commercial: 508-651-4847).

Enclosures

Karl E. Friedl
KARL E. FRIEDL
CPT, MS
Research Physiologist

APPENDIX J. Distribution of height measurement discrepancies.



Distribution of the difference between height reported by MEPS and by soldiers' first units, compared to study team measured height. Positive values indicate overestimated heights compared to study team measurements.

APPENDIX K. Study data compared by age category & ethnic origin.

Male recruits, by age category [in metric units]

Parameter	17-20	21-27	prob
EAD (n =)	**751**	**251**	
Age (years)	18.5 ±0.8	22.9 ±1.8	
Height (cm)	175.3 ±6.8 a	175.0 ±7.9	ns
Weight (kg)	75.1±12.0	77.2±12.9	*
BMI (kg/m2)	24.4 ±3.6	25.1 ±3.6	**
Body fat (%)	15.6 ±5.8	17.2 ±5.6	***
Neck circ (cm)	37.1 ±2.1	37.5 ±2.2	**
Abd2 circ (cm)	82.4 ±9.5	84.8 ±9.5	***
BF std prox (%)	-4.4 ±5.8	-4.8 ±5.6	ns
Strength (kg)	45.9±20.5	47.4±22.1	ns
Flexibility (cm)	85.1±17.5	83.3±18.3	ns
Push ups (count)	26.5±15.3	26.8±16.8	ns
Situps (count)	38.7±17.9	36.0±19.0	*
2-mile run (mins)	16.3 ±2.2	16.5 ±2.1	ns
6-MTHS POST-BT	**303**	**82**	
Weight (kg)	75.6 ±9.5	77.3±11.7	ns
BMI (kg/m2)	24.7 ±2.8	25.3 ±3.3	ns
Body fat (%)	15.2 ±4.5	16.7 ±5.1	**
Neck circ (cm)	38.8 ±9.0	38.5 ±2.1	ns
Abd2 circ (cm)	82.2 ±7.1	84.9 ±8.7	**
BF std prox (%)	-4.8 ±4.5	-5.2 ±5.1	ns
Wt chg (6m-EAD)	+0.9 ±5.5	+0.8 ±5.1	ns
Wt chg (BT-EAD)	-0.1 ±3.1	-0.0 ±2.8	ns
%BF chg (6m-EAD)	-0.5 ±3.2	-0.3 ±3.2	ns

Note: significant differences by analysis of variance are noted in right column: ns=not significant, *=p<0.05, **=p<0.01, ***=p<0.001. proportions were compared as 2 x 2 tables with a chi-squared test.

Female recruits, by age category [in metric units]

Parameter	18-20	21-27	F prob
EAD (n =)	**639**	**208**	
Age (years)	18.5 ±0.9	23.1 ±1.8	
Height (cm)	161.6 ±6.4	162.9 ±6.8	*
Weight (kg)	57.6 ±6.2	59.5 ±7.2	***
BMI (kg/m2)	22.0 ±2.0	22.4 ±2.2	*
Body fat (%)	26.5 ±3.7	26.9 ±3.9	ns
Neck circ (cm)	31.4 ±1.4	31.7 ±1.5	*
Hip circ (cm)	93.4 ±5.2	94.5 ±5.6	*
Forearm circ (cm)	23.0 ±1.2	23.3 ±1.4	***
Wrist circ (cm)	14.8 ±0.7	14.9 ±0.7	ns
Abd1 circ (cm)	67.1 ±4.5	68.7 ±4.8	***
BF std prox (%)	-1.5 ±3.7	-3.1 ±3.9	***
Strength (kg)	28.9 ±8.3	30.7 ±8.8	**
Flexibility (cm)	86.8±15.4	86.9±14.7	ns
Push ups (count)	7.0 ±7.7	7.0 ±7.8	ns
Situps (count)	26.5±18.7	26.2±19.5	ns
2-mile run (mins)	20.3 ±2.4	20.4 ±1.7	**
6-MTHS POST-BT	**203**	**68**	
Weight (kg)	60.3 ±6.8	60.6 ±6.7	ns
BMI (kg/m2)	23.0 ±2.2	23.0 ±2.4	ns
Body fat (%)	26.5 ±4.1	25.6 ±4.6	ns
Neck circ (cm)	32.6 ±2.1	33.1 ±1.3	ns
Hip circ (cm)	95.1 ±5.3	95.2 ±5.5	ns
Forearm circ (cm)	24.1 ±1.7	24.3 ±1.6	ns
Wrist circ (cm)	15.5 ±1.1	15.4 ±0.9	ns
BF std prox (%)	-1.5 ±4.1	-4.4 ±4.6	***
Wt chg (6m-EAD)	+2.3 ±3.7	+2.0 ±3.3	ns
Wt chg (BT-EAD)	-1.0 ±1.9	-1.3 ±2.3	*
%BF chg (6m-EAD)	-0.4 ±3.4	-0.7 ±2.9	ns

Male recruits, by principal ethnic groups

Parameter	White	Black	Hispanic	prob
EAD (n =)	**615**	**325**	**68**	
Age (years)	20.1 ±3.3	20.0 ±3.0	20.6 ±3.0	ns
Height (cm)	175.7 ±7.0 a	175.8 ±7.1 a	171.4 ±5.9 b	***
Weight (kg)	76.2±12.3	75.8±12.2	73.0±12.4	ns
BMI (kg/m^2)	24.6 ±3.5	24.5 ±3.6	25.8 ±3.9	ns
Body fat (%)	17.1 ±5.7 a	13.8 ±5.3 b	17.7 ±6.1 a	***
Neck circ (cm)	37.2 ±2.1	37.2 ±2.1	36.9 ±2.0	ns
Abd2 circ (cm)	84.6 ±9.8 a	80.1 ±8.4 b	84.2±10.5 a	***
BF std prox(%)	-3.6 ±5.7 a	-6.8 ±5.2 b	-3.2 ±6.1 a	***
% overwt (acc)	4.7	5.2	7.4	ns
% overwt (ret)	30.9	29.5	36.8	ns
% overfat	27.0	12.3	32.4	***
Strength (kg)	44.4±21.0 a	51.5±19.6 b	44.0±22.1 a	***
Flexibility (cm)	85.1±17.5 a	84.8±17.5 a	78.5±18.3 b	*
Push ups (count)	24.9±15.5 a	29.2±15.8 b	27.2±15.3 ab	***
Situps (count)	36.4±19.0 a	41.0±17.1 b	35.9±16.0 a	***
2-mile run (mins)	16.5 ±2.2	16.1 ±2.0	16.2 ±1.7	ns
6-MTHS POST-BT	**208**	**129**	**23**	
Weight (kg)	75.3 ±9.8	77.3 ±9.9	75.4 ±9.0	ns
BMI (kg/m^2)	24.6 ±2.7	25.1 ±3.0	25.5 ±2.8	ns
Body fat (%)	16.1 ±4.5 a	14.0 ±4.5 b	17.8 ±4.4 a	***
Neck circ (cm)	39.4±10.1	37.7 ±3.1	37.7 ±1.8	ns
Abd2 circ (cm)	83.5 ±7.4 a	81.0 ±7.1 b	85.2 ±7.5 a	**
BF std prox(%)	-4.4 ±4.5 a	-6.6 ±4.5 b	-2.7 ±4.6 a	***
Wt chg (6m-EAD)	+0.9 ±5.0	+1.1 ±5.8	+0.1 ±7.1	ns
Wt chg (BT-EAD)	-0.4 ±3.1 a	+0.4 ±3.1 b	-0.2 ±2.7 a,b	**
%BF chg (6m-EAD)	-0.4 ±3.1	-0.0 ±3.4	-1.1 ±4.1	ns

Note: significant differences by ANOVA (rt col: ns=not significant, *=p<0.05, **=p<0.01, ***=p<0.001) were pursued with Duncan's multiple range test (same symbols = no difference); proportions were compared as row x column contingency tables with a chi-squared test.

Female recruits, by principal ethnic groups

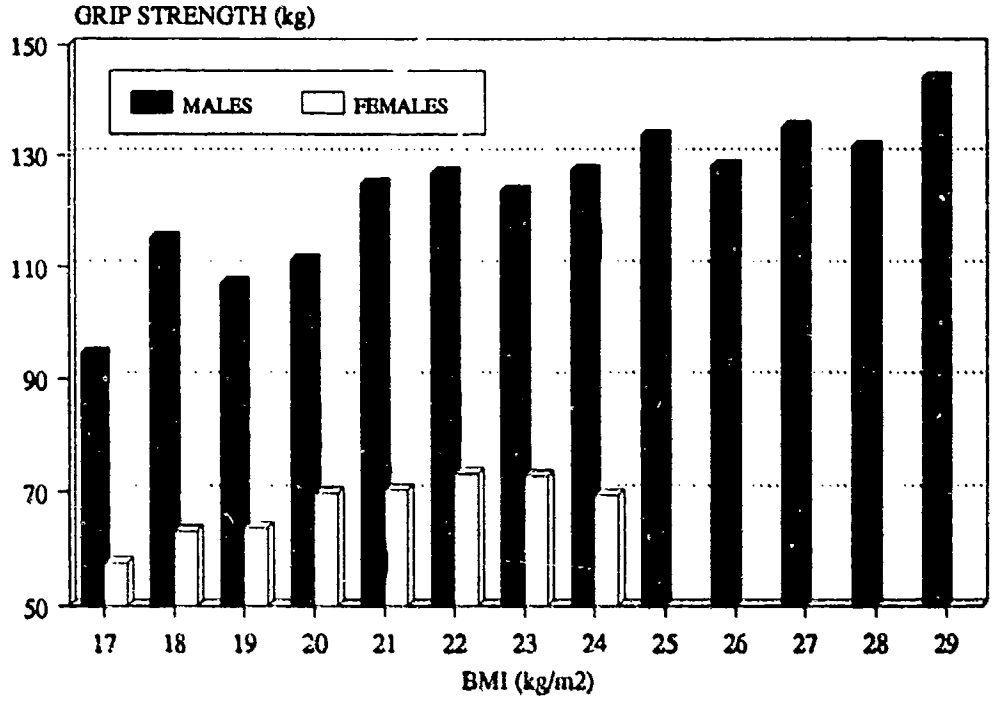
Parameter	White	Black	Hispanic	prob
EAD (n =)	**379**	**368**	**52**	
Age (years)	20.3 ±3.2	19.9 ±3.1	20.1 ±3.1	ns
Height (cm)	162.1 ±6.3 a	162.4 ±6.7 a	157.8 ±5.9 b	***
Weight (kg)	58.8 ±6.3 a	57.8 ±6.5 b	55.5 ±6.3 c	**
BMI (kg/m2)	22.3 ±2.0 a	21.9 ±2.0 b	22.3 ±2.0 a,b	*
Body fat (%)	27.3 ±3.6 a	25.9 ±4.0 b	27.8 ±3.2 a	***
Neck circ (cm)	31.4 ±1.4 a	31.7 ±1.5 b	31.0 ±1.4 a	**
Hip circ (cm)	94.5 ±5.2 a	93.1 ±5.4 b	92.5 ±5.0 b	***
Forearm circ (cm)	23.1 ±1.3 a	23.1 ±1.3 a	22.4 ±1.2 b	**
Wrist circ (cm)	14.9 ±0.7 a	14.9 ±0.8 a	14.6 ±0.6 b	*
Abd1 circ (cm)	68.3 ±4.8 a	66.8 ±4.4 b	67.5 ±5.0 a,b	***
BF std prox(%)	-1.4 ±3.6 a	-2.6 ±4.0 b	-0.7 ±3.3 a	***
% overwt (acc)	35.4	29.1	25.0	ns
% overwt (ret)	40.7	32.7	38.5	ns
% overfat	34.7	25.2	38.5	**
Strength (kg)	28.4 ±8.6 a	30.8 ±8.5 b	27.5 ±4.5 a	***
Flexibility (cm)	87.9±16.3	85.9±15.0	86.9±14.0	ns
Push ups (count)	6.7 ±7.7	7.4 ±7.5	7.3±10.0	ns
Situps (count)	24.5±19.3 a	29.1±17.8 b	26.0±18.5 a,b	**
2-mile run (mins)	19.8 ±2.6 a	20.7 ±2.5 b	20.2 ±1.9 a,b	*
6-MTHS POST-BT	**133**	**129**	**14**	
Weight (kg)	60.8 ±6.9	60.3 ±6.6	59.6 ±7.8	ns
BMI (kg/m2)	23.1 ±2.3 a	22.9 ±2.2 a	24.4 ±2.0 b	*
Body fat (%)	26.6 ±4.3 a	25.5 ±4.0 b	29.6 ±4.3 c	**
Neck circ (cm)	32.6 ±1.6	32.9 ±2.2	32.8 ±1.5	ns
Hip circ (cm)	95.2 ±5.5	95.3 ±5.3	94.9 ±6.9	ns
Forearm circ (cm)	24.0 ±1.6 a	24.4 ±1.7 b	23.6 ±1.4 a,b	*
Wrist circ (cm)	15.4 ±0.9	15.6 ±1.3	15.0 ±0.3	ns
BF std prox(%)	-2.0 ±4.3 a	-3.1 ±4.3 b	+1.1 ±4.6 c	**
Wt chg (6m-EAD)	+1.8 ±3.3	+2.7 ±3.8	+3.0 ±3.2	ns
Wt chg (BT-EAD)	-1.2 ±2.1	-1.0 ±1.9	-0.9 ±1.1	ns
%BF chg (6m-EAD)	-0.7 ±3.0	-0.4 ±4.0	+0.2 ±2.5	ns

APPENDIX L. Summary study data, key variables.

Parameter	EAD	EOC	first unit
MALES, n =	1483	1230	546
Height (cm)	175.2 ±7.1 (153.0-208.0)	*	*
Weight (kg)	75.7±12.2 (48.6-121.7)	74.8±11.0 (49.0-111.0)	75.9±10.0 (52.3-113.2)
BMI (kg/m2)	24.6 ±3.6 (17.2-34.4)	24.4 ±3.1 (17.4-32.9)	24.8 ±2.9 (18.4-33.2)
Body fat (%)	16.1 ±5.8 (2.1-36.1)	N/C	15.5 ±4.7 (5.0-32.4)
Push ups (count)	26.4±15.9 (0.0-87.0)	50.9±12.2 (18.0-96.0)	N/C
Situps (count)	36.4±19.0 (3.0-85.0)	64.5±11.1 (31.0-99.0)	N/C
2-mile run (mins)	16.4 ±2.2 (11.4-26.0)	14.0 ±1.1 (11.0-20.1)	N/C
FEMALES, n =	1159	884	298
Height (cm)	162.0 ±6.5 (144.0-189.0)	*	*
Weight (kg)	58.3 ±6.5 (40.0-87.7)	56.9 ±6.2 (41.8-81.8)	60.5 ±6.8 (43.2-80.0)
BMI (kg/m2)	22.2 ±2.0 (16.4-27.2)	21.8 ±1.9 (15.6-28.4)	23.1 ±2.2 (16.4-30.0)
Body fat (%)	26.8 ±3.8 (15.8-42.6)	N/C	26.3 ±4.2 (11.5-40.8)
Push ups (count)	7.0 ±7.7 (0.0-52.0)	27.5 ±9.9 (7.0-79.0)	N/C
Situps (count)	34.0±13.8 (1.0-92.0)	61.3±11.4 (10.0-98.0)	N/C
2-mile run (mins)	20.3 ±2.5 (13.0-29.8)	17.5 ±1.5 (13.0-30.8)	N/C

notes: values given as mean±SD, and range; N/C - data not collected;
*** EAD height was used for all body fat and BMI computations**

APPENDIX M. Relationship between grip strength and body mass index.



The relationship between grip strength and body mass index in males and females (males: $r=0.43$, $p<0.001$; females: $r=0.29$, $p<0.001$).

GLOSSARY

Terms and abbreviations used in this report

Accession standards - physical standards prescribed by AR 40-501. These are weight-for-height standards which prevent entry to active duty of candidates who exceed the standards. Waivers can be granted in some cases and, since completion of the data collection in this study, candidates are being accepted if they exceed these weight tables but meet body fat standards in AR 600-9.

APFT - the Army Physical Fitness Test which is administered to all active duty soldiers biannually. The test includes pushups, situps and two mile run, in that order. At the beginning of basic training a modified APFT, the diagnostic APFT, is administered to new recruits. This may include a one mile instead of two mile run test.

BMI - Body Mass Index: a way to describe body size and proportion from height and weight: weight (in kilograms) is divided by the square of the height (in meters). Weight increases more rapidly with an increase in height so that a normally proportioned 6' person will be described by the same BMI as a normally proportioned 5' person. The "average" BMI for young U.S. males and females is approximately 22-23 kg/m^2.

EAD - Entry to Active Duty.

MEPS - Military Entrance Processing Station; a facility which inprocesses new recruits before basic training.

NHANESII - National Health and Nutrition Examination Survey; the second cycle of field data collection from a large representative sample of households across the United States. This data includes physical measurements of height and weight.

Overfat - exceeding Army retention body fat limits for sex and age.

Recruit - person in basic training, afterwards referred to as a soldier.

Retention standards - physical standards prescribed by AR 600-9. These are fat standards based on circumference measurements which pertain to Army personnel. Weight tables are only used for screening purposes, to determine who should be assessed for fat.

Screening weight standards - weight-for-height tables in AR 600-9 which identify individuals who are most likely to be overfat. This is used only to identify those soldiers who need to be assessed for body fat.

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