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Body mass index, medical qualification status, and discharge during the first year of US Army service[1–4]

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ABSTRACT

Background: The high prevalence of overweight and obesity in military recruits and in the US population as a whole necessitates understanding the health effects of body composition and associated morbidity.

Objective: In this study, we examined the effect of body mass index (BMI; in kg/m^2) and medical status on premature discharge from the US Army in a large cohort of first-time–enlisted, active-duty soldiers.

Design: We determined the odds ratios (ORs) associated with BMI and medical status at enlistment by using a retrospective cohort of first-time, active-duty army recruits.

Results: ORs for BMI, calculated by using 24–24.9 as a reference, exhibited a U-shaped pattern. Soldiers with a BMI >34 had the highest ORs for all-cause (OR: 1.47; 95% CI: 1.32, 1.64) and medical (OR: 1.68; 95% CI: 1.46, 1.93) discharges. A BMI <17 was 1.35 times as likely (95% CI: 1.02, 1.80) to result in an all-cause discharge and 1.45 times as likely (95% CI: 1.01, 2.08) to result in a medical discharge. ORs for soldiers who required a medical reexamination did not vary when all-cause discharge (OR: 1.10; 95% CI: 1.06, 1.14) and medical discharge (OR: 1.10; 95% CI: 1.05, 1.15) were compared. The medical discharge OR for soldiers who required a medical waiver to enter the army (OR: 1.56; 95% CI: 1.48, 1.64) was higher than the OR for all-cause discharge (OR: 1.27; 95% CI: 1.22, 1.32).

Conclusion: Enlistment BMI and medical qualification status play an important role in early discharge and may provide a valuable tool in the development of fitness, nutrition, and injury-prevention interventions in higher-risk groups. *Am J Clin Nutr* 2011;93:608–14.

INTRODUCTION

Extremes of body mass index (BMI; in kg/m^2), especially the categories of overweight and obese, and their associated health effects have been increasingly targeted for health policy intervention in recent years in the US military and general population as a whole (1–4). Increases in the prevalence of overweight and obese in the US population have corresponded to increases in overweight and obese in the recruit populations for the military and other public service jobs (5, 6), and the leading reason for military applicant disqualification was a failure to meet body-composition standards (3, 7). The Accession Medical Standards Analysis and Research Activity at Walter Reed Army Institute of Research was established to support the development of evidence-based standards for military enlistment to ensure military recruit populations are medically fit and ready to undertake all aspects of military service and to minimize the morbidity and premature separation associated with military service. Because of the high prevalence of overweight and obesity in military recruits and the US population as a whole, it is important to understand the health effects of body composition and the associated morbidity and related premature separation.

Recent research has shown that higher BMI is associated with decreased fitness (8–13) and increased risk of pain, injury, disability, and premature retirement or discharge (12, 14–20) in firefighters, police, and military personnel. Although some recent studies have shown an association between underweight and risk of injury, illness, and premature discharge in population-based civilian samples (20, 21) and military personnel (16, 17), the increasing prevalence of overweight and obesity has resulted in less emphasis placed on the evaluation of risks associated with underweight, particularly in military personnel (23). Underweight and normal-weight BMI are frequently grouped together (9–11), or the underweight are excluded from the study population (12), when body composition is the focus.

Studies of overweight and underweight as risk factors for injury or premature separation in military personnel, firefighters, and police have reported inconsistent findings. Although some authors reported risk associated with a nonnormal BMI exhibited as a linear relation (24), other authors measured BMI as a continuous variable, which obscured the presence of a U-shaped risk curve (25) or observed increases in risk of premature separation, injury, or illness associated with extremes of BMI, although not all associations were significant (8, 15–17, 19–22, 26). Nearly all

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studies that categorized BMI used broader classifications of BMI on the basis of the National Institutes of Health (NIH) categorization (27), which may obscure risk in individuals who approach, but do not cross, the defined BMI cutoff for more extreme categories (underweight, overweight, and obese) (8, 10–13, 15–18, 26).

The primary objective of this study was to examine the effect of BMI, particularly extremes of BMI, on premature discharge from the US Army in a large cohort of first time–enlisted, active-duty soldiers. With the use of finer groupings of BMI than the widely used NIH BMI categories (27), we assessed the effect of BMI on both medical discharge and discharge for any reason, while the medical status at time of application to the military was controlled for. As a secondary objective, the independent effect of medical qualification status at the time of application to both medical discharge and discharge for any reason was evaluated.

SUBJECTS AND METHODS

Study population

First-time–enlisted, active-duty, US Army service members with no prior service and an entry date between 1 January 2002 and 31 December 2006 listed in the Department of Defense personnel records were eligible for inclusion in this study. Exclusion criteria included invalid or missing information on sex, BMI, age, race, or education or a height below minimum or greater than maximum standards (28).

Data collection

All data elements were routinely collected by personnel of Military Entrance Processing Stations as part of the normal army entry process and reflected the individual's status at time of entry.

BMI was calculated by using weight and height at the time of entry into the military. Army applicants who exceed the upper limits of weight for height (BMI ≈27) underwent further screening to measure body fat percentage (estimated by using waist, neck, and hip circumferences); applicants who meet weight-for-height standards were considered qualified regardless of the body fat percentage (28). The Assessment of Recruit Motivation and Strength Program was implemented in October 2006 and allowed applicants who exceeded body fat standards for enlistment (up to a maximum 30% for men and 36% for women, regardless of age) to enter if they could pass a fitness test. Therefore, some recruits who entered between October 2006 and December 2006 exceeded army body fat standards. To examine the relation between BMI and premature separation in detail, especially in cases where it was on the cusp of the NIH BMI categorization of underweight, normal weight, overweight, and obese, BMI was categorized into 19 categories, each including one unit of BMI (<17, 17–17.9, 18–18.9, 19–19.9, 20–20.9, 21–21.9, 22–22.9, 23–23.9, 24–24.9, 25–25.9, 26–26.9, 27–27.9, 28–28.9, 29–29.9, 30–30.9, 31–31.9, 32–32.9, 33–33.9 ≥34)

The medical qualification status of subjects was recorded at the time of the preenlistment medical examination (29). Specified medical conditions were considered permanently disqualifying, but applicants with certain conditions that are not severe, easily treatable, or unlikely to negatively affect military service may receive a medical waiver after more complete review of additional medical records, tests, and consultations (30). If an applicant had a condition that was not permanently disqualifying (most commonly, a positive marijuana drug test or exceeding weight-for-height and body fat standards) and subsequently had negative marijuana tests or weight-for-height or body fat within standards, he or she was classified as "medical reexamination required."

Demographic data, which were assessed at the time of entry, included age, race, education, and marital status, and were obtained from military applicant and personnel databases. For purposes of this study, demographic data were used as control

TABLE 1
Demographic characteristics of the study population

	Count	Percentage
BMI category		
<17 kg/m^2	296	0.1
17–17.9 kg/m^2	3372	1.3
18–18.9 kg/m^2	9636	3.6
19–19.9 kg/m^2	15,966	6.0
20–20.9 kg/m^2	21,960	8.3
21–21.9 kg/m^2	26,240	9.9
22–22.9 kg/m^2	26,992	10.2
23–23.9 kg/m^2	27,379	10.3
24–24.9 kg/m^2	24,543	9.2
25–25.9 kg/m^2	22,400	8.4
26–26.9 kg/m^2	21,616	8.1
27–27.9 kg/m^2	18,109	6.8
28–28.9 kg/m^2	13,004	4.9
29–29.9 kg/m^2	10,800	4.1
30–30.9 kg/m^2	8388	3.2
31–31.9 kg/m^2	5906	2.2
32–32.9 kg/m^2	3781	1.4
33–33.9 kg/m^2	2383	0.9
≥34 kg/m^2	2695	1.0
Medical qualification status		
No disqualifications	220,468	83.0
Medical waiver required	17,827	6.7
Medical reexamination required[1]	27,171	10.2
Sex		
Male	217,653	82.0
Female	47,813	18.0
Age at entry		
≤20 y	165,595	62.4
21–25 y	74,420	28.0
26–30 y	18,590	7.0
>30 y	6861	2.6
Race		
White	202,389	76.2
Black	42,048	15.8
Other	21,029	7.9
Marital status		
Single	223,512	84.2
Married	37,736	14.2
Other	4218	1.6
Education		
Less than high school	1334	0.5
High school diploma	240,570	90.6
Some college	11,962	4.5
College graduate or above	11,600	4.4

[1] Including, but not limited to, exceeding weight-for-height and body fat standards and positive urine drug screen for marijuana.

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TABLE 2
Frequency and rate of discharge by BMI category and medical status: all-cause compared with medical discharge

	All-cause discharge			Medical discharge		
	Count	Percentage	Rate (per 1000)	Count	Percentage	Rate (per 1000)
BMI category						
<17 kg/m^2	62	0.2	209.46	35	0.2	118.2
17–17.9 kg/m^2	621	1.6	184.16	327	1.7	97.0
18–18.9 kg/m^2	1555	4.1	161.34	829	4.2	86.0
19–19.9 kg/m^2	2389	6.3	149.82	1209	6.1	75.7
20–20.9 kg/m^2	3082	8.1	140.56	1527	7.7	69.5
21–21.9 kg/m^2	3677	9.6	140.17	1882	9.5	71.7
22–22.9 kg/m^2	3676	9.6	136.33	1858	9.4	68.8
23–23.9 kg/m^2	3865	10.1	141.22	1903	9.6	69.5
24–24.9 kg/m^2	3408	8.9	138.93	1732	8.7	70.6
25–25.9 kg/m^2	3233	8.5	144.42	1715	8.7	76.6
26–26.9 kg/m^2	3116	8.2	144.19	1687	8.5	78.0
27–27.9 kg/m^2	2576	6.8	142.37	1351	6.8	74.6
28–28.9 kg/m^2	1829	4.8	140.90	970	4.9	74.6
29–29.9 kg/m^2	1516	4.0	140.42	819	4.1	75.8
30–30.9 kg/m^2	1262	3.3	150.45	692	3.5	82.5
31–31.9 kg/m^2	890	2.3	150.81	485	2.4	82.1
32–32.9 kg/m^2	561	1.5	148.33	322	1.6	85.2
33–33.9 kg/m^2	376	1.0	158.01	194	1.0	81.4
≥34 kg/m^2	448	1.2	165.86	261	1.3	96.8
Medical qualification status						
No disqualifications	30,595	80.2	138.8	15,524	39.2	70.4
Medical waiver required	3005	7.9	168.6	1902	4.8	106.7
Medical reexamination required[1]	4542	11.9	167.2	2372	6.0	87.3

[1] Including, but not limited to, exceeding weight-for-height and body fat standards and positive urine drug screen for marijuana.

variables. Demographic variables were selected for inclusion in the model if the variable was independently associated with BMI or medical qualification status and also independently associated with premature discharge.

Premature separation was defined as a record with a discharge date <365 d after the date of entry. Medical discharges were defined by using the Defense Manpower Data Center interservice separation codes. Individuals with interservice separation codes that indicated a medical disqualification, including medical conditions that existed before service, a disability discharge for medical conditions acquired during service, the failure to meet weight and body fat standards, or being medically unqualified for active duty and with a separation date ≤365 d of their entrance date, were defined as medical discharges. Medical discharges and all-cause discharges were analyzed separately.

Statistical analyses

Soldiers were followed for 1 y (365 d) after their military entrance date. Logistic regression modeling was used to calculate the odds of early discharge for BMI categories, medical qualification status, and control variables. Odds ratios (ORs) and associated 95% CIs were derived from the logistic regression models that compared individuals who experienced discharge ≤1 y of service with those who remained in the service for >1 y. The following two models were generated: one model calculated the odds of any discharge ≤1 y, and one model calculated the odds of experiencing a medical discharge. Adjusted ORs were calculated for BMI category by using the median category (24–24.9) as the referent group and for medical qualification status by using no disqualifications as the referent group. All analyses controlled for sex, age, race, marital status, education, and BMI category or medical status, respectively. No evidence of a statistical interaction between any of the variables was shown; therefore, no interaction terms were included in the final model. All analyses were performed with SAS statistical software version 9.2 (SAS Institute, Cary, NC). The study was performed under a minimal risk human-use protocol reviewed and approved by the Walter Reed Army Institute of Research Institutional Review Board.

RESULTS

Less than 1% of eligible participants had invalid or missing entries for sex, BMI, age, race, or education and were excluded from this study. Individuals with heights <58 or >80 in, who comprised <0.01% of total participants, were also excluded. After applying exclusion criteria, the final population included 265,466 nonprior service-enlisted, active-duty soldiers. Demographic characteristics of the study population are shown in **Table 1**. Most study participants were men (81.9%), white (76.2%), <20 y old at the time of entrance into the military (62.4%), and high school graduates (90.6%). Subject BMIs between 20 and 27 (64.5%) were the most common and, most of these subjects had no disqualifications at the time of the preenlistment medical examination (83%).

The frequency and rate of discharge by BMI category and by medical qualification status for both medical and all-cause

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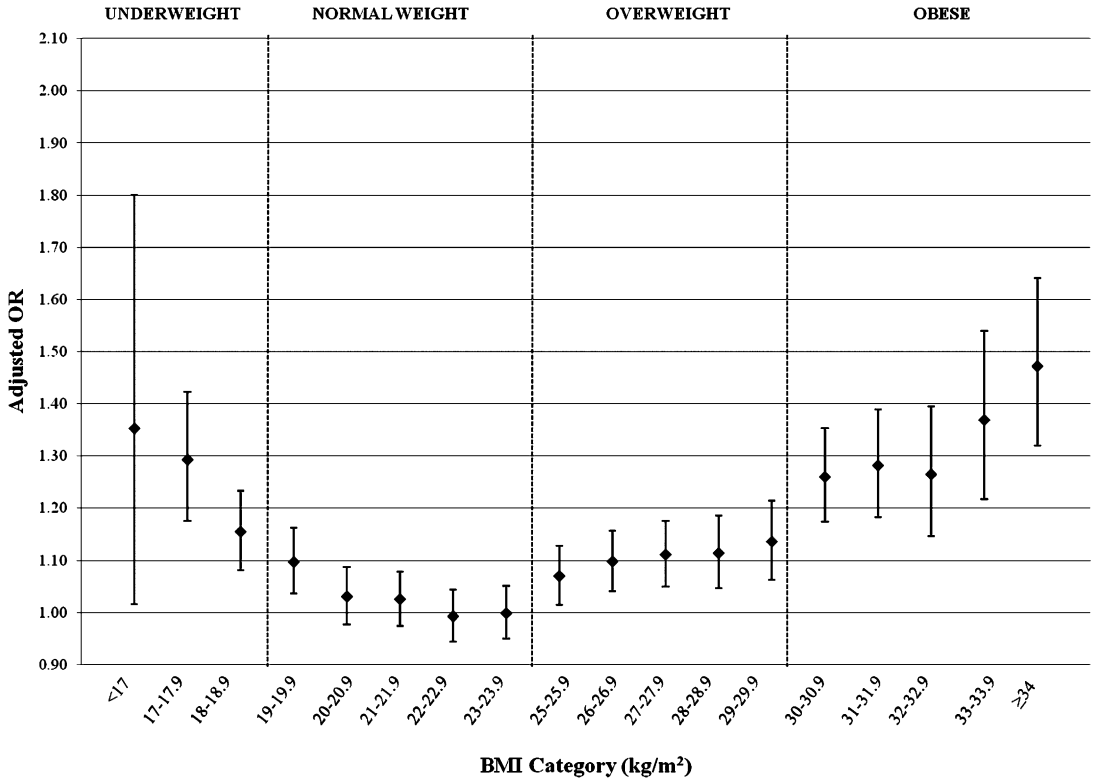

FIGURE 1. Adjusted odds ratios (ORs) and 95% CIs for all-cause discharge by category of BMI (in kg/m^2; reference: 24–24.9). Multiple logistic regression models included BMI category, medical qualification status, sex, age, race, marital status, and education. Diamonds, adjusted OR point estimate; vertical lines, upper and lower bounds of 95% CI.

discharge are shown in **Table 2**. Subjects with BMIs lower and higher than the normal category had higher rates of medical and all-cause discharges, with clear U-shaped patterns observed. The highest rates of all-cause discharge were observed in subjects with BMI <18, with the highest rates observable in subjects with BMI <17, followed by subjects who had BMI between 17 (209.5 discharges per 1000 individuals) and 17.9 (184.2 discharges per 1000 individuals). Elevated rates of discharge were also observable in individuals with BMI >33 (BMI: 33– 33.9: 158.0 subjects; BMI ≥34: 165.9 subjects), although the rates of discharge were less than the rate of discharge in those with BMI <18. Rates of medical discharge by BMI category followed similar patterns.

Soldiers who required a medical waiver to enter the army and soldiers who required a medical reexamination before entry had similar rates of all-cause discharge (168.6 and 167.2, respectively) that were elevated relative to the rate (138.8) for soldiers who had no disqualifications. However, soldiers who required a medical waiver experienced a higher rate of medical discharge (106.7) relative to the rates of soldiers who required a medical reexamination before entry (87.3) and soldiers with no disqualifications at the medical examination (70.4).

The adjusted ORs and 95% CIs for a discharge in ≤1 y by BMI category for all-cause discharge and medical discharge, respectively, with medical qualification status, sex, age, race, marital status, and education controlled for, are shown in **Figures 1** and **2**. Borders of the NIH BMI categories are also shown on the figures. A clear U-shaped pattern was observed, with the highest odds of discharge observed in subjects with the highest and lowest BMI categories, when medical qualification status, sex, race, age, education, and marital status were controlled for. The odds of medical (OR: 1.68; 95% CI: 1.46, 1.93) and all-cause (OR: 1.47; 95% CI: 1.32, 1.64) discharges were highest in subjects with BMI >34.

Soldiers with BMI <17 experienced the second highest odds of a medical discharge and the third highest odds of an all-cause discharge. Those with BMI <17 were 1.35 times as likely (95% CI: 1.02, 1.80) to experience an all-cause discharge and 1.45 times as likely (95% CI:1.01, 2.08) to experience a medical discharge. In the BMI category that approached the lower bounds of the normal-weight classification (19–19.9), a significantly increased odds of discharge was observable for both medical and all-cause discharges. The likelihood of all-cause and medical separations decreases incrementally as BMI approached 20 but remained significant.

Adjusted ORs associated with a medical qualification status at the time of the preenlistment physical, with BMI category, sex, age, race, marital status, and education controlled for, are shown in **Table 3**. ORs associated with requiring a medical reexamination did not vary when all-cause (OR: 1.10; 95% CI: 1.06, 1.14) and medical (OR: 1.10; 95% CI: 1.05, 1.15) discharges were compared, although though both were significant. However, the odds of a medical discharge in subjects who required a medical waiver to enter the army (OR: 1.56; 95% CI: 1.48, 1.64) was higher than the odds of an all-cause discharge (OR: 1.27; 95% CI: 1.22, 1.32) and higher than in subjects who required a medical reexamination. The distribution of specific medical conditions associated with requiring a medical waiver

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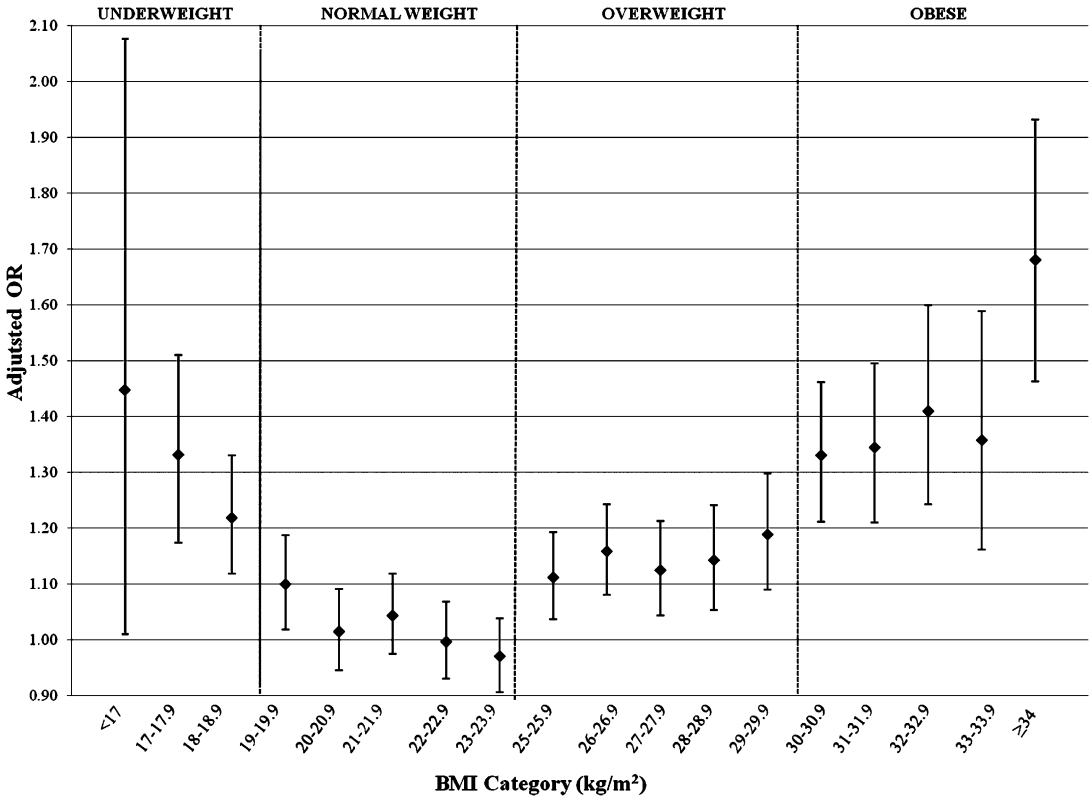

FIGURE 2. Adjusted odds ratios (ORs) and 95% CIs for medical discharge by category of BMI (in kg/m^2; reference: 24–24.9). Multiple logistic regression models included BMI category, medical qualification status, sex, age, race, marital status, and education. Diamonds, adjusted OR point estimate; vertical lines, upper and lower bounds of 95% CI.

in soldiers who experienced a medical discharge and soldiers who experienced a discharge for any reason were similar.

DISCUSSION

Significant associations between lowest and highest BMI categories and all-cause and medical discharges during the first year of service in a large cohort of army personnel were shown in this study. The observed relation between extremes of BMI and discharge was shown to have a U-shaped pattern of an increased relative odds for a premature discharge in subjects with BMI <20 and >25, with medical conditions that were preexisting at the time of enlistment, and with demographic factors controlled for. In addition, we showed an increased likelihood of medical and all-cause discharges during the first year of service for subjects who required a medical waiver before entry or had a medical condition at the time of application that was remediated before enlistment.

This study extended previous findings of risk associated with underweight (14–17) by showing a significant increase in all-cause and medical discharges in those who meet the NIH definition of normal weight (BMI of 18.5–25) but who had a BMI <20. These applicants were permitted to enter the army without additional screening for either fitness or body fat percentage, both of which have been used for further screening of applicants who exceeded weight-for-height or body fat standards (28). A BMI <20 is as common as obesity in this population, but has not traditionally been the focus of studies of morbidity in military populations.

In subjects who required a medical reexamination before entry, we showed the likelihood of a discharge to be similar for all-cause and medical discharges. Because most medical disqualifications of this type are the result of exceeding weight-for-height standards, we hypothesized that many of these individuals lost weight to meet weight-for-height standards before enlistment. This finding suggested that exceeding weight-for-height standards may be associated with a premature discharge, even after the weight has been lost and weight-for-height standards have been met. Further studies are necessary to determine the extent to which the elapsed time between the initial disqualification for exceeding weight-for-height standards and delayed entry is associated with injuries in this population.

Findings with respect to soldiers who required a medical waiver before enlistment are more difficult to interpret. The distribution of medical conditions among the medical waiver–

TABLE 3
Medical qualification status: all-cause compared with medical discharge[1]

	All-cause discharge	Medical discharge
No disqualifications	—	—
Waiver required	1.27 (1.22, 1.32)	1.56 (1.48, 1.64)
Medical reexamination required[2]	1.10 (1.06, 1.14)	1.10 (1.05, 1.15)

[1] All values are adjusted odds ratios; 95% CIs in parentheses. Multiple logistic regression models included BMI category, medical status, sex, age, race, marital status, and education.

[2] Including, but not limited to, exceeding weight-for-height and body fat standards and positive urine drug screen for marijuana.

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required group was similar when all-cause and medical discharges were compared. Results from previous Accession Medical Standards Analysis and Research Activity studies indicate that the relation between medical waivers and a discharge varies on the basis of the condition waived (31–34); however, further research is necessary to determine how BMI modifies risk associated with requiring a medical waiver.

There are limitations to the interpretation of our findings. First, one of the primary predictors in this study was BMI at entry into the military. Because of its association with morbidity and mortality and its ease of use in population health studies, BMI is widely used as a surrogate for body fat (35). However, it is well documented that BMI does not measure body fat well in individuals with high muscle mass, including men in the military (23, 36–39).

Second, the army assesses body fat in those who exceed weight-for-height standards to determine whether body-composition standards are met. If an applicant has BMI between 16 and 27 and meets all other enlistment standards, he or she is allowed to enter the army (28). Applicants with BMI >27 undergo anatomical circumferential measurements to determine whether they exceed age- and sex-specific body fat standards. The result of these classifications is that some individuals in our study population had BMI that indicated that they were overweight or obese even though the army has not designated them as exceeding body fat standards. Although these individuals who were classified as overweight or obese did not exceed body fat standards, the results of this study suggested that they were at increased risk of premature separation.

Third, BMI was measured at the time of entry, not at the time of discharge, which occurred ≤1 y later in our study population. Body weight can vary greatly in ≤1 y, especially when the individual is subjected to rigorous physical- fitness training. This phenomenon has been studied by Friedl et al (9), who documented frequent weight loss in male and female trainees who exceeded body fat standards and male and female trainees who were overweight, although the weight loss was more pronounced in men. Weight gain during basic training was also observed and was most common in the leanest women. Weight at the end of basic combat training is not routinely collected for centralized military databases and was unavailable for this study. Therefore, BMI at time of entry likely overestimated discharge BMI for obese soldiers and underestimated discharge BMI for underweight soldiers and may not have been proximate in time to the outcome of interest. However, the results of this study suggested that enlistment BMI and medical status at the time of the preenlistment physical play an important role in early discharge and may provide a valuable tool in the development of fitness, nutrition, and injury-prevention interventions in higher-risk groups.

Fourth, smoking status was unmeasured in this population. Previous studies of military personnel have shown significant association between smoking and increased risk of injury, which is a risk factor for premature discharge (19, 40) and discharge (41–44). In a separate study, we showed associations between BMI and musculoskeletal injury that were similar to the findings in the current report, when smoking status was controlled for. In addition, we showed that the relation between BMI and injury was not confounded by smoking (45). Therefore, although we could not exclude the possibility of some degree of residual confounding of the association between BMI and premature discharge observed in this study because of the smoking status of study participants, it should not be assumed that the observed associations between underweight and premature separation in this study were completely attributable to unmeasured smoking status.

Finally, separation codes are fairly general in nature and did not allow us to ascertain the specific medical diagnosis associated with a medical discharge, and this limited our ability to interpret the precise cause for discharge. In addition, convenient separation codes, including entry-level performance, character or behavior, and existed before service, are used to discharge recruits that cannot fulfill training requirements relatively early in basic combat training, which may have resulted in some misclassification of medical discharges as discharges for behavioral reasons (41, 46) and in imprecise measurement of medical discharge of an outcome.

In conclusion, notwithstanding these limitations, we have shown an increase in the likelihood of discharge in underweight soldiers for medical reasons that approach that of the more extensively studied obese body composition. These findings extend current knowledge of risk factors of injury and disability in military personnel and may help to inform training and recruitment of other public service personnel, including firefighters and police. Because of the level of increased risk of discharge in underweight and obese subjects and in subjects who experienced temporary and permanent disqualifications, the army should consider appropriate interventions for these groups. These populations of underweight and obese recruits may benefit from testing to determine their fitness and motivation to complete military service before entering the army.

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The authors' responsibilities were as follows—DWN, SAB, and DNC: design of study; ERP: data collection; ERP and DNC: statistical analyses; and ERP, DWN, SAB, and DNC: writing of the manuscript. None of the authors had a conflict of interest.

REFERENCES

1. Lowery B. Obesity policy spotlight: New trends in obesity policy. Bariat Nurs Surg Pat. 2009;4:325–6.
2. Nestle M, Jacobson MF. Halting the obesity epidemic: a public health policy approach. Public Health Rep 2000;115:12–24.
3. Christeson W, Taggart AD, Messner-Zidell S. Too fat to fight: retired military leaders want junk food out of America's schools. Washington, DC: Mission: Readiness, April 2010.
4. Lindquist CH, Bray RM. Trends in overweight and physical activity among US military personnel, 1995-1998. Prev Med 2001;32:57–65.
5. Franke WD, Ramey SL, Shelle MC. Relationship between cardiovascular disease morbidity, risk factors, and stress in a law enforcement cohort. J Occup Environ Med 2002;44:1182–9.
6. Hsu LL, Nevin RL, Tobler SK, Rubertone MV. Trends in overweight and obesity among 18-year-old applicants to the United States military, 1993-2006. J Adolesc Health 2007;41:610–2.
7. Niebuhr DW, Cavicchia MA, Bedno SA, et al. Accession medical standards analysis and research activity, annual report 2009. Walter Reed Army Institute of Research. Silver Spring, MD, 2009. Available from: http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA506472 (cited 31 July 2010).
8. Knapik JJ, Canham-Chervak M, Hauret K, Hoeddebecke E, Laurin MJ, Cuthie J. Discharges during US Army basic training: injury rates and risk factors. Mil Med 2001;166:641–7.

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9. Friedl KE, Vogel JA, Bovee MW, Jones BH. Assessment of body weight standards in male and female army recruits. Exercise Physiology Division. Natlick, MA: US Army Research Institute of Environmental Medicine, 1989. (Technical report no. T15-90.)
10. Clark S, Rene A, Theurer WM, Marshall M. Association of body mass index and healthy status in firefighters. J Occup Environ Med 2002;44: 940–6.
11. Fahs CA, Smith DL, Horn GP, et al. Impact of excess body weight on arterial structure, function, and blood pressure in firefighters. Am J Cardiol 2009;104:1441–5.
12. Soteriades ES, Hauser R, Kawachi I, Christiani DC, Kales SN. Obesity and the risk of job disability in male firefighters. Occup Med (Lond) 2008;58:245–50.
13. Tsismenakis AJ, Christophi CA, Burress JW, Kinney AM, Kim M, Kales SN. The obesity epidemic and future emergency responders. Obesity (Silver Spring) 2009;17:1648–50.
14. Nabeel I, Baker BA, McGrail MP, Flottenmesch TJ. Correlation between physical activity, fitness, and musculoskeletal injuries in police officers. Minn Med 2007;90:40–3.
15. Knapik JJ, Darakjy S, Hauret KG, et al. Increasing the physical fitness of low-fit recruits before basic combat training: an evaluation of fitness, injuries, and training outcomes. Mil Med 2006;171:45–54.
16. Billings CE. Epidemiology of injuries and illnesses during the United States Air Force Academy 2002 Basic Cadet Training program: documenting the need for prevention. Mil Med 2004;169:664–70.
17. Poston WS, Haddock K, Talcott GW, Klesges RC, Lando HA, Peterson A. Are overweight and obese airmen at greater risk of discharge from the United States Air Force? Mil Med 2002;167:585–8.
18. Reis JP, Trone DW, Macera CA, Rauh MJ. Factors associated with discharge during Marine Corps basic training. Mil Med 2007;172: 936–41.
19. Knapik JJ, Jones SB, Darakjy S, et al. Injuries and injury risk factors among members of the United States Army Band. Am J Ind Med 2007; 50:951–61.
20. Kyröläinen H, Häkkinen K, Kautiainen H, Santtila M, Pihlainen K, Häkkinen A. Physical fitness, BMI and sickness absence in male military personnel. Occup Med (Lond) 2008;58:251–6.
21. Lusky A, Barell V, Lubin F, et al. Relationship between morbidity and extreme values of body mass index in adolescents. Int J Epidemiol 1996;25:829–34.
22. Wilkins K, Mackenzie SG. Work injuries. Health Rep 2007;18:25–42.
23. Friedl KE. Can you be large and not be obese? The distinction between body weight, body fat, and abdominal fat in occupational standards. Diabetes Technol Ther 2004;6:732–49.
24. Neovius M, Kark M, Rasmussen F. Association between obesity status in young adulthood and disability pension. Int J Obes (Lond) 2008;32: 1319–26.
25. Trone DW, Villasenor A, Macera CA. Negative first-term outcomes associated with lower extremity injury during recruit training among female Marine Corps graduates. Mil Med 2007;172:83–9.
26. Talcott GW, Haddock CK, Klesges RC, Lando H, Fielder E. Prevalence and predictors of discharge in United States Air Force Base Military Training. Mil Med 1999;164:269–74.
27. National Institutes of Health/National Heart, Lung, and Blood Institute. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. September 1998. Available from: http://www.nhlbi.nih.gov/guidelines/obesity/ob_gdlns.pdf (cited 5 April 2010).
28. Army Regulation 40-501. Standards of medical fitness. Version current 14 January 2008. Available from: http://www.army.mil/usapa/epubs/xml_pubs/r40_501/cover.xml (cited 5 April 2010).
29. Army Regulation 601-210. Active and reserve components enlistment program. Version current 7 July 2007. Available from: http://www.army.mil/usapa/epubs/xml_pubs/r601_210/cover.xml (cited 5 April 2010).
30. Niebuhr DW, Powers TE, Li Y, Millikan AM. The enlisted accession medical process. In: DeKoning, ed. Textbook of military medicine. Recruit medicine. Falls Church, VA: Office of the Surgeon General, US Army, 2006:45–58.
31. Cox KA, Clark KL, Li Y, Powers TE, Krauss MR. Prior knee injury and risk of future hospitalization and discharge from military service. Am J Prev Med 2000;18(3 suppl):112–7.
32. Jankosky C, Niebuhr DW, Powers TE, Krauss MR. Attrition of military enlistees with a medical waiver for chronic headache, 1995-2000. Mil Med 2006;171:1235–8.
33. Otto WC, Niebuhr DW, Powers TE, Krauss MR, McVeigh FL, Tarbett AK. Attrition of military enlistees with a medical waiver for myopia, 1999-2001. Mil Med 2006;171:1137–41.
34. Krauss MR, Russell RK, Powers TE, Li Y. Accession standards for attention-deficit/hyperactivity disorder: a survival analysis of military recruits, 1995-2000. Mil Med 2006;171:99–102.
35. Garrow JS, Webster J. Quetelet's index (W/H2) as measure of fatness. Int J Obes 1985;9:147–53.
36. Heinrich KM, Jitnarin H, Suminski RR, et al. Obesity classification in military personnel: a comparison of body fat, waist circumference, and body mass index measurements. Mil Med 2008;173:67–83.
37. Mullie P, Vansant G, Hulens M, Clarys P, Degrave E. Evaluation of body fat estimated from body mass index and impedance in Belgian male military candidates: comparing two methods for estimating body composition. Mil Med 2008;173:266–70.
38. Malavolti M, Battistini NC, Dugoni M, Bagni B, Bagni I, Pietrobelli A. Effect of intense military training on body composition. J Strength Cond Res 2008;22:503–8.
39. Jette M, Sidney K. Fitness, performance, and anthropometric characteristics of 19,185 Canadian forces personnel classified according to body mass index. Mil Med 1990;155:120–6.
40. Kaufman KR, Brodine S, Shaffer R. Military training-related injuries: surveillance, research, and prevention. Am J Prev Med 200;18(3 suppl):54–63.
41. Booth-Kewley S, Larson GE, Ryan MA. Predictors of Navy attrition. I. Analysis of 1-year attrition. Mil Med 2002;167:760–9.
42. Conway TL, Woodruff SI, Hervig LK. Women's smoking history prior to entering the US Navy: a prospective predictor of performance. Tob Control 2007;16:79–84.
43. Klesges RC, Haddock CK, Chang CF, Talcott W, Lando HA. The association of smoking and the cost of military training. Tob Control 2001;10:43–7.
44. Larsson H, Broman L, Harms-Ringdahl K. Individual risk factors associated with premature discharge from military service. Mil Med 2009;174:9–20.
45. Cowan DN, Bedno SA, Urban N, Yi B, Niebuhr DW. Musculoskeletal injuries among overweight male Army trainees: incidence and healthcare utilization. Occup Med (in press).
46. Niebuhr DW, Powers TE, Krauss MR, Cuda AS, Johnson BM. A review of initial entry training discharges at Fort Leonard Wood, MO for accuracy of discharge classification type: fiscal year 2003. Mil Med 2006;171:1142–6.

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