Obesity in the United Kingdom Armed Forces: Prevalence Based on Measured and Self-Reported Data

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ABSTRACT Objectives: To assess the prevalence of obesity in the United Kingdom military and general population and the extent to which self-reported data underestimates obesity. Methods: Height and weight data from military personnel (measured data: 2,073 men, 308 women; self-reported data: 6,374 men, 609 women) and from the general population (measured data: 1,121 men, 1,396 women; self-reported data: 1,234 men, 1,543 women). Results: Obesity (defined as having a body mass index of 30+) was 6.2% in those under 25 years old and 24.5% in those over 35 years old in military males, and the prevalence of obesity was 12% in those under 25 years old and 25% in those over 35 years old in military women. Self-reported body mass index underestimated obesity. Conclusions: Obesity is uncommon in those under 25 years old in the United Kingdom military. The prevalence of obesity based on self-reported data underestimates true prevalence.

INTRODUCTION

The Armed Forces aim to select and retain individuals who will be suited to meet the physical demands of military service. It follows that military personnel would be expected to have a lower risk of obesity than the general population because of the emphasis on physical fitness, the presumed low interest of obese youngsters to join the military, and the medical admission examination which would preclude or limit the admission of obese people to the military. Prevalence of obesity at the time of recruitment into the military is low,[1–4] although the prevalence has been increasing.[5–7] A U.S. report warned that obesity, which has reached a prevalence of 18% in those under 30 years in the general population, may have an impact on eligibility for recruitment.[4] But there is no evidence that recruitment policies regarding obesity have changed.

Information on the prevalence of obesity in the military is limited and usually relies on reported data on height and weight[6,8,9] or on unrepresentative small samples.[10] These studies show that the prevalence of obesity in the military is below that of the general population in western countries. However, studies of U.S. veterans and their families indicate that obesity is a serious problem in those who left the Services.[9,11]

Studies in the general population have found that respondents underestimate their weight, whereas height is overestimated, and this results in an underestimate of body mass index (BMI).[12] Thus, it is possible that obesity rates have been underestimated in the military.[6,8,9] The magnitude of underreporting in the general population varies according to sex, BMI status, age, educational level, and ethnicity,[13–19] but there are exceptions.[20] The preponderance of young personnel in the military could decrease the underestimation of BMI because it has been noted that differences between reported and measured BMI increase with age,[16–18,21] and military personnel may perceive the relevance to monitor their level of fatness.

This study was carried out using data from 2 large studies in the United Kingdom Armed Forces; one of them obtained information on self-reported height and weight[22] and the other on measured height and weight data.[23] Based on the data from these studies, we estimated the prevalence of obesity in these studies. The aims of the current study were to assess whether the prevalence of obesity in the military was similar to the general population, to assess the extent to which the prevalence of obesity would have been underestimated when using self-reported rather than measured weight and height data, and to assess whether it would be possible to correct for any underestimation of obesity in studies that only obtained self-reported height and weight.

METHODS

Measured height and weight data came from a study undertaken by QinetiQ (provider of technology-based services and solutions to the defense, United Kingdom) and included information on 2,470 individuals. QinetiQ carried out a study for the United Kingdom Ministry of Defence to ensure that equipment and clothing would allow personnel to function efficiently. A quota sample design was used to ensure that most groups of the United Kingdom Armed Forces would be represented. The proposed target was to collect information on 4,500 Service personnel with at least 1,000 from each Service with the outstanding balance from the Army. The United Kingdom Armed Forces were at an unprecedented level of activity during 2007 (the data collection phase of the survey), which meant that the total sample assessed in the study was 2,470, as a large percentage of the personnel selected for the study were away from their bases during the visits. Women

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who were pregnant or lactating were excluded from this study. Service personnel were briefed about the study and asked to give signed consent. Information on sex, age, Service, ethnic origin, and rank were collected via a self-administered questionnaire. Height was measured using a stadiometer, with the subject standing erect looking straight ahead, as the vertical distance from the floor to the top at vertex delimited by a straight headpiece. Weight was assessed with the subject standing erect, looking straight ahead on the platform of an electronic digital scale.

Self-reported data came from the King's Centre for Military Health Research's health of military personnel study, which was conducted in 2004 and 2005.[22] This study was the first wave of a cohort study of United Kingdom Armed Forces personnel comparing the physical and mental health between a randomly selected sample of those who participated in TELIC 1 (the codename used by the United Kingdom military for the war fighting phase [January 18, 2003–April 28, 2003]) and a group randomly selected from those who did not participate in TELIC 1 but were serving in the United Kingdom military at that time (defined as Era). A random sample stratified according to Service strength and enlistment type (regulars, reserves) was asked to participate. We contacted those who were sampled, regardless of whether they had left the Armed Forces, at least 3 times to elicit completion of our questionnaire. In total, 4,722 personnel who were deployed on TELIC 1 and 5,550 who were in the Era sample completed a questionnaire postdeployment on their background, military experiences, and health outcomes. The overall adjusted response rate was 61%, and we found no evidence of response bias by health status.[24] Participants were asked to give details of their current height and weight; this was converted (if necessary) into centimeters and kilograms to allow BMI to be calculated.

Data from the 2004 Health Survey for England (HSE) and the 2007 Adult Psychiatric Morbidity Survey were used to make comparisons between the prevalence of obesity in the United Kingdom military personnel and the general population.[25–27] The HSE is based on a nationally representative sample of the general population of England using a multistage stratified probability sample with postcode sectors as primary sampling units and the postcode address file as the sampling frame for households. Weight and height were measured using an electronic digital scales and Chasmors stadiometers, respectively.[25,26] The 2007 Adult Psychiatric Morbidity Survey is also a probability sample of community-dwelling adults in England.[27] A multistage stratified sampling design was used with stratification by socioeconomic status and geographical region. The questions to obtain height and weight were the following: how tall are you without clothes on? And what's your weight without clothes on? Aggregate data from these 2 studies were made available to us; hence, we have restricted certain analyses to military personnel only for which we have individual respondent data. The researchers of this current investigation were granted ethical approval by the Ministry of Defence Research Ethics Committee.

Analytical Sample

For the purposes of these analyses and to allow direct comparisons between the measured and self-reported data, the samples were restricted to regular personnel who were still in service at the time of data collection. Further, individuals were only included if they had valid height and weight data and they were under 45 years of age. This resulted in 2,381 military personnel with measured data and 6,983 with self-reported data.

BMI Cutoffs

We generated the BMI for each individual by using the following equation:

$$\text{BMI} = \frac{\text{weight (kg)}}{\text{height}^2\,(\text{m}^2)}.$$

A number of cutoffs have been recommended to determine the level of obesity; we have used three cutoffs, i.e., 25+, 27.5+, and 30+. However, the main analysis focused on BMI 30+ because fat mass is more likely to explain high BMI in this group than fat-free mass, as it is more likely in those with a BMI below 30 (J. Sundin, N.T. Fear, S. Wessely, R.J. Rona, unpublished data).

Statistical Analyses

All analyses have been undertaken separately for men and women and study sample (i.e., military self-reported data, military measured data, general population self-reported data, general population measured data). This allows comparison to be made between each study (i.e., mode of data collection) and within each study to allow comparisons of men and women. In the analysis to find an inflated algorithm to correct for self-reported height and weight, a random 50% sample was selected for estimating the appropriate correction factor and applied in the remaining 50% of the sample. All analyses have been undertaken using the statistical software package, STATA (version 10) (StataCorp LP; College Station, Texas).

RESULTS

Table I shows the descriptive statistics of the 2 military studies by sex. Comparing men and women from each study shows that those in the self-reported study are more likely (than those in the measured study) to be older ($p < 0.001$) in the Army ($p < 0.001$), hold the rank of officer (women, $p = 0.003$; males, $p < 0.001$), and be white (women, $p = 0.019$; males, $p < 0.001$). Women from the measured study had a significantly higher BMI than women from the self-reported study ($p = 0.026$). Men from the self-reported study were taller and heavier than those from the measured study ($p < 0.001$). Within each study, men are more likely than women to be in the Army or Marines, have higher BMI, height, and weight (for all comparisons, $p < 0.001$). Women are more likely than men to be officers (measured study: $p = 0.03$; self-reported study: $p < 0.001$).

TABLE I. Descriptive Characteristics of 2 Military Studies by Sex (Measured Data, $N = 2{,}381$ [Males = 2,073, Females = 308]; Self-Reported Data, $N = 6{,}983$ [Males = 6,374, Females = 609])

	Males		Females	
Variable	Measured Data ($n = 2{,}073$)	Self-Reported Data ($n = 6{,}374$)	Measured Data ($n = 308$)	Self-Reported Data ($n = 609$)
Age (years), Mean (95% confidence interval [CI])	27.6 (27.3–27.9)	31.4 (31.2–31.6)	26.2 (25.6–26.8)	29.4 (28.9–29.9)
Service, *n* (%)				
Army	996 (48.1)	4,079 (64.0)	84 (27.3)	346 (56.8)
Royal Air Force	464 (22.4)	1,240 (19.5)	135 (43.8)	156 (25.6)
Navy	432 (20.8)	785 (12.3)	89 (28.9)	107 (17.6)
Royal Marines	181 (8.7)	270 (4.2)	—	—
Rank, *n* (%)				
Other Ranks	1,856 (89.5)	5,380 (85.1)	263 (85.4)	467 (77.2)
Officer	217 (10.5)	940 (14.9)	45 (14.6)	138 (22.8)
Missing	—	54	—	4
Ethnicity, *n* (%)				
White	1,795 (86.6)	5,446 (96.1)	286 (92.9)	541 (96.4)
Non-white	277 (13.4)	223 (3.9)	22 (7.1)	20 (3.6)
Missing	1	705	—	48
BMI (kg/m^2), Mean (95% CI)	26.0 (25.9–26.2)	26.2 (26.1–26.3)	25.3 (24.8–25.7)	24.6 (24.3–25.0)
Height (cm), Mean (95% CI)	177.0 (176.7–177.3)	179.1 (178.9–179.2)	165.5 (164.8–166.2)	166.3 (165.7–166.8)
Weight (kg), Mean (95% CI)	81.7 (81.2–82.3)	84.0 (83.7–84.3)	69.4 (68.0–70.7)	68.1 (67.0–69.1)

Table II presents the mean BMI and the prevalence of obesity (defined as having a BMI of 30+) by age, sex, and population (military and general population). In all groups, the mean BMI and the prevalence of obesity were greater as age increased (with the exception of self-reported obesity among women in the military). The prevalence of obesity was consistently lower in the self-reported samples than in the measured samples in the military and general population. The prevalence of obesity in the measured sample of the military under 20 years was 4.4% in males and 7.7% in women, indicating that obesity existed even in those recently recruited into the Services, albeit to a low level (Table II).

Table III shows the associations between being overweight and obese in relation to each military study (measured data vs. self-reported data) by sex. Unadjusted analyses show that males from the self-reported study are more likely to be overweight/obese (using the 25+ cutoff) than males from the measured study; however, following adjustment, the association was reversed (i.e., males from the measured study are more likely to be overweight/obese than males from the self-reported study). Following adjustments, males from the self-reported study were less likely to be overweight/obese (using the 27.5+ and 30+ cutoffs) than males from the measured study. Age accounted for this change in the direction of the association. Compared to women from the measured study, women from the self-reported study were less likely to be overweight/obese; these differences remained following adjustment.

We investigated whether an inflated algorithm could be generated for adjusting prevalence in studies using self-reported measurements by assessing in 50% of the samples, whether adjusted prevalences based on Service, age, rank, and ethnicity could be applied in the remaining 50% of the sample. We found that our inflated algorithms performed well in some groups, but in the majority of the groups it tended to overestimate obesity (data not shown).

We did not find that the differences in weight and height between the self-reported and the measured sample increased with increasing BMI. The differences in height between the 2 groups was about 2 cm and the difference in weight was 1 kg, in those with a BMI less than 25 and in those with a BMI of 30 or more (data not shown).

DISCUSSION

Main Results

The main findings of this study were that, in men, the prevalence of obesity increased with age; the prevalence of obesity in the military population is similar to the general population; BMI based on self-reported weight and height markedly underestimates the prevalence of obesity in the military; and the inflationary adjustment algorithms to take account for the level of underreporting do not appear to be an adequate correction for the self-reported data.

Interpretation of the Results

Our results were limited to obesity (BMI of 30 or more), and we did not include estimates of overweight because of the difficulty in distinguishing fat-free mass from fat mass in those with a BMI 25–29.9, especially in Service personnel (J. Sundin, N.T. Fear, S. Wessely, R.J. Rona, unpublished data).[28] It was unexpected to find that obesity was present even under the age of 20 years, albeit at a lower prevalence rate than in the general population. Current guidelines bar applicants

TABLE II. Mean BMI (and SE) and the Prevalence (%) of Obesity (Using a Cutoff of 30+ kg/m^2) by Study, Age Group (in years), and Sex

	Age Group (years)		
	<25	25–34	35–44
Men			
Measured Data			
Mean BMI, Mean (SE)			
Military (N = 2,073)[a]	24.8 (0.11)	26.4 (0.12)	27.8 (0.19)
General Population (N = 1,121)[b]	24.0 (0.31)	26.4 (0.21)	27.7 (0.19)
Prevalence of Obesity, %			
Military (N = 2,073)[a]	6.2	15.0	24.5
General Population (N = 1,121)[b]	8.2	18.8	24.5
Self-Reported Data			
Mean BMI, Mean (SE)			
Military (N = 6,374)[c]	25.6 (0.09)	26.1 (0.06)	27.1 (0.08)
General Population (N = 1,234)[d]	23.8 (0.32)	25.9 (0.30)	26.6 (0.18)
Prevalence of Obesity, %			
Military (N = 6,374)[c]	4.4	10.9	16.5
General Population (N = 1,234)[d]	9.0	12.3	18.0
Women			
Measured Data			
Mean BMI, Mean (SE)			
Military (N = 308)[a]	24.8 (0.34)	25.3 (0.33)	27.3 (0.67)
General Population (N = 1,396)[b]	24.5 (0.30)	25.8 (0.25)	26.7 (0.22)
Prevalence of Obesity, %			
Military (N = 308)[a]	11.9	10.7	25.0
General Population (N = 1,396)[b]	12.2	17.9	23.6
Self-Reported Data			
Mean BMI, Mean (SE)			
Military (N = 609)[c]	24.0 (0.35)	24.8 (0.24)	24.9 (0.42)
General Population (N = 1,543)[d]	23.9 (0.39)	25.0 (0.21)	26.0 (0.21)
Prevalence of Obesity, %			
Military (N = 609)[c]	4.5	9.4	9.0
General Population (N = 1,543)[d]	9.9	14.0	19.1

[a]QinetiQ study. [b]HSE 2004. [c]King's Centre for Military Health Research's military study. [d]2007 Adult Psychiatric Morbidity Survey.

at preservice assessment from entry to a military career in the United Kingdom Armed Forces if BMI is above 28, unless waist circumference is low.[29] It is possible that entry examinations were less consistent up to 2008. It was also unexpected to find that the prevalence of obesity in serving personnel over the age of 35 years was similar to that of the general population and that in the age group of 25–34 years the rate of obesity was only slightly below the rates seen in the general population. We are not aware of another recent population study in the military based on measured weight and height in a triservice study. A population study representative of the military population from the United States was based on self-reported weight and height.[8] This study reported levels of obesity below the U.S. general population (based on measured height and weight),[8] but we know that self-reported weight and height is likely to underestimate the true prevalence of obesity,[12] though the magnitude of the underestimation varies according to the characteristics of the participants.[12–19]

Our study is unique in demonstrating that self-reported weight and height in the military may underestimate "true" obesity. Our finding is based on 2 separate studies; thus, reported and measured height and weight were not obtained from the same subjects. It is possible that the 2 populations are different despite being based on studies carried out on samples from most subgroups of the United Kingdom Armed Forces and were adjusted to take into account differences in Service and demographic characteristics.

Nyholm et al[18] suggested that the consistent underestimation of obesity using reported measurements could be corrected by using an algorithm, which takes into account variables that are predictive for misreporting. We tried this approach by estimating an inflationary algorithm in a random 50% of the sample for which reported weight and height was available and then applying it to the remaining 50%. We are sceptical that this approach would solve the problem, as in our study there was some evidence of overinflating the estimates, albeit reaching a significant level only with one cutoff in males.

Our 2 studies were carried out during a period of unprecedented activity, in which the main concerns were related

TABLE III. Association Between Being Overweight/Obese and Being in Either Study by Sex (Measured Data, N = 2,381 [Males = 2,073, Females = 308]); Self-Reported Data, N = 6,983 [Males = 6,374, Females = 609])

	Males		Females	
	Odds ratio (OR) (95% CI)	Adjusted OR[a] (95% CI)	OR (95% CI)	Adjusted OR[a] (95% CI)
Overweight/Obese (25+)				
Measured Data	1.0	1.0	1.0	1.0
Self-Reported Data	1.13 (1.03–1.25)	0.83 (0.74–0.93)	0.70 (0.53–0.92)	0.66 (0.48–0.91)
Overweight/Obese (27.5+)				
Measured Data	1.0	1.0	1.0	1.0
Self-Reported Data	1.01 (0.91–1.12)	0.73 (0.65–0.82)	0.55 (0.40–0.77)	0.47 (0.32–0.68)
Obese (30+)				
Measured Data	1.0	1.0	1.0	1.0
Self-Reported Data	0.87 (0.75–1.01)	0.65 (0.55–0.77)	0.60 (0.39–0.94)	0.58 (0.35–0.97)

ORs and 95% CIs are presented. [a]Adjusted OR for service, age, rank, and ethnicity.

to overstretching of the United Kingdom Armed Forces and training activities related to preparation for deployment to Iraq and Afghanistan.[30] There are several possible explanations for our results. Those who have a combat trade may be less likely to become obese than those with a support role. However, in a smaller study in which the predominant group had a combat role, the prevalence of obesity was also high.[31] Serving personnel are medically examined at least every 5 years, but it is stated that BMI should not be used alone as a reason for determining suitability for employment.[29] Their fitness is also assessed annually, and we know that obese personnel will have more difficulty to fulfill the requirements, but we do not have data on failure rates of obese personnel in the United Kingdom Armed Forces. In the U.S. Army, personnel who exceed weight-for-height allowances and percentage of body fat are placed in the Army Weight Control Programme and must lose weight or face disciplinary action, which may include separation from the U.S. Army.[32] However, an overtly punitive policy may have unwarranted side effects such as taking up smoking, using laxatives, or other inappropriate measures.[32]

Strengths and Limitations of the Studies

The 2 military studies were based on large surveys including personnel survey from most groups of the United Kingdom Armed Forces, and they were broadly similar to the distributions of the total United Kingdom Armed Forces.[33] The prevalence of obesity based on measured weight and height are likely to represent the situation in the United Kingdom Armed Forces, as the methods of measurement were consistent throughout the study. The response rates were satisfactory at around 60%. It is possible that some people may have systematically avoided being measured. Personnel who may have been reluctant to participate in this study would be those who are obese. Thus, if any bias related to nonparticipation occurred in this study, it would have tended to increase rather than decrease the prevalence of obesity.

As mentioned earlier, the comparison of obesity between the 2 studies is limited as the samples were not selected in the same way and the sampling approaches used by the studies differed (random vs. quota sampling for the 2 military studies; however, both the general population studies used probability sampling). However, the consistency of our results with other studies,[8,12] the consistency of the differences regardless of the characteristics, and the adjustment for service-demographic variables justify the approach used.

Implications

The finding in this study that obesity is a serious problem in the United Kingdom Armed Forces is compelling. Prevention of obesity is of paramount importance for occupational and health reasons. There is a need to create awareness of the importance to adjust diet to energy expenditure, especially in a group that may need high energy food intake during demanding periods of training. However, concepts of balance in terms of energy intake and energy expenditure are difficult to convey and may need specialized personnel, at least, to develop feasible and understandable diets. Such an intervention is important because of the evidence that obesity continues to be a serious problem after leaving the military.[9]

In conclusion, obesity is an important problem in the United Kingdom Armed Forces and medical services need to be aware that the prevalence of obesity on the basis of self-reported weight and height underestimates true prevalence.

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