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**ABSTRACT**

Excess body weight or body fat hinders performance of military duties. As a result, the U.S. military has weight-for-height and percent body fat standards for enlistment. This paper estimates the number and percent of military-age civilians who meet, and do not meet, the current active duty enlistment standards for weight and body fat for the four major armed services (Army, Navy, Air Force, Marine Corps), using data from the full series of National Health and Nutrition Examination Surveys that spans 1959-2008. We find that the percent of civilian military-age men and women who satisfy current military enlistment standards for weight-for-height and percent body fat has fallen considerably. This is due to a large increase in the percentage who are both overweight and overfat, which roughly doubled for men and more than tripled for women between 1959-62 and 2007-08. As of 2007-08, 5.7 million men (11.70%) and 16.5 million women (34.65%) of military age exceed the U.S. Army's enlistment standards for weight-for-height and percent body fat. The implications of rising obesity for the U.S. military are especially acute given its recent difficulties in recruiting a sufficient number of new high quality service members in the midst of combat operations overseas.

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## Introduction

The Department of Defense (DoD) is the largest employer in the United States (NRC, 2006); in 2008 there were over 1.4 million men and women on active duty and 1.1 million men and women in the military reserves (U.S. Census Bureau, 2010). Approximately 184,000 new military personnel must be recruited each year to replace those who leave the service because of retirement or other reasons (U.S. Bureau Labor Statistics, 2009). In the past decade, recruitment has become more challenging for the U.S. military, which has been strained by two major overseas operations: Operation Iraqi Freedom (March 20, 2003 – September 1, 2010), which recently became Operation New Dawn (September 1, 2010 – present), and Operation Enduring Freedom – Afghanistan (October 7, 2001 – present). These operations, which increased the military's demand for recruits (in particular, by the Army and Marine Corps) have also decreased the supply of applicants because they raise the risk of injury and death (Asch et al., 2010). In order to meet its recruiting targets, the U.S. Army was forced to substantially expand the availability and size of enlistment bonuses between 2004 and 2008 (Asch et al., 2010).

This paper focuses on the implications for U.S. military recruiting of one important trend over the past several decades: the rise in overweight and obesity. Between 1959-62 and 2007-08, the age-adjusted prevalence of overweight (defined as a body mass index<sup>2</sup>, or BMI, of 25 or higher) among adult males in the U.S. rose from 47.4% to 68.3% and the prevalence of obesity (defined as a BMI of 30 or higher) among adult males in the U.S. tripled from 10.7% to 32.2% (Flegal et al., 1998; Flegal et al., 2002; Flegal et al., 2010). The prevalence of obesity defined using percent body fat (instead of BMI) has also increased dramatically in the past five decades (Burkhauser et al., 2009).

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<sup>2</sup> Body mass index (BMI) is calculated as weight in kilograms divided by height in meters squared.

Physical fitness in general and body weight and body fat in particular are highly relevant to military occupations (Institute of Medicine (IOM), 1990, 2004; Naghii, 2006). Militaries worldwide have long valued a physically fit appearance as an important signal of strength, discipline, and professionalism, and consider it important for morale and pride and thus effectiveness (IOM 2004; Yamane, 2007; McLaughlin and Wittert, 2009). Military service often requires muscular and cardio-respiratory endurance, which can be hampered when body fat is excessive (U.S. DoD, 2004). Several studies have found that heavier individuals, especially women, are more likely to fail basic training than healthy weight individuals (Jones et al., 1988; Knapik et al., 2001; Poston et al., 2002). Among Navy personnel, men and women with high weight-for-height are more likely to fail their semi-annual Physical Readiness Test (Bohnker et al, 2005). It is estimated that, among U.S. active duty military, overweight and obesity are responsible for 658,000 missed work days (absenteeism) and the equivalent of 17,000 missed work days due to lower productivity while at work (presenteeism), for a total productivity cost of \$105.6 million per year (Dall et al., 2007). TRICARE, the military health insurance program, spends \$1.1 billion annually treating obesity-related illness (Dall et al., 2007). For comparison, that is more than it spends annually treating illnesses related to tobacco (\$564 million) and alcohol consumption (\$425 million) combined (Dall et al., 2007). The IOM has warned that obesity “threaten[s] the long-term welfare and readiness of U.S. military forces” (IOM, 2004, p.1) and an association of retired generals and admirals has declared that rising youth obesity threatens the future strength of the U.S. military and thus U.S. national security (Mission: Readiness, 2010).

Because of the importance of healthy body weight and percent body fat for military readiness and effectiveness, the military imposes weight-for-height and percent body fat

standards for enlistment. The high and rising prevalence of obesity in the civilian population makes it more difficult for the military to find acceptable numbers of quality recruits (Yamane, 2007; McLaughlin and Wittert, 2009). Excessive weight and/or body fat is now the most common reason for medical disqualification, leading to rejection of 23.3% of all applicants to the military (NRC, 2006). For comparison, the second most common reason is smoking marijuana, which leads to rejection of 12.6% of applicants (NRC, 2006). Roughly 15,000 applicants to the military are rejected each year for exceeding the standards for weight and body fat (Mission: Readiness, 2010).

This paper estimates the number and percent of the civilian military-age population that satisfy current active duty enlistment standards for weight-for-height and percent body fat. Results are reported by gender and separately for the Army, Navy, Air Force, and Marine Corps. We document both current levels and trends over the past five decades. We also examine the personal characteristics associated with meeting those enlistment standards.

This paper relates to several previous studies. Recently, a collection of retired generals and admirals issued a report, “Too Fat to Fight,” which expressed concern that the increase in youth obesity may compromise military readiness and national security (Mission: Readiness, 2010). That report listed the percentage of 18-24 year old Americans who were overweight or obese in 2006-2008, but did not calculate what fraction met military enlistment standards for weight-for-height and percent body fat. Moreover, the estimates of the prevalence of overweight and obese were based on self-reported weight and height, which tend to be substantially underreported (e.g. Rowland, 1974; Cawley and Burkhauser, 2006), potentially resulting in severe and systematic misclassification error (Nieto-Garcia et al., 1990). Other studies have used a subset of the data examined in this paper to calculate the percent of Americans meeting

military weight-for-height standards in a narrow span of years; e.g. Nolte et al. (2002) examines 1988-94 and Yamane (2007) examines 2001-04. Those papers did not examine whether subjects met the military standards for percent body fat.

This paper offers four improvements over the previous literature. First, we examine levels and trends over a much longer period: 1959-2008. Second, we examine not only whether civilians satisfy the military enlistment standards for weight-for-height but also those for percent body fat. Third, weight and height are measured by medical professionals rather than self-reported as in Mission: Readiness (2010). Fourth, we investigate which personal characteristics predict meeting the standards.

Defense economists have noted that there has been relatively little research on the economics of military manpower and human resource issues in the military (Sandler and Hartley, 1995).<sup>3</sup> This paper represents a contribution to the literature, as “There is scant literature covering civilian obesity levels and military recruitment” (Yamane, 2007, p. 1160).

### **Military Standards for Weight-For-Height and Percent Body Fat**

General physical standards for enlistment in the American military can be traced back to 1775, when Congress called for “able bodied” men to be formed into militia (Johnson, 1997). Weight-for-height standards for enlistment were first issued in 1887 for men and in the 1940s for women; initially their primary function was to exclude those who were underweight (Johnson, 1997), but in recent years far more applicants are excluded for being overweight (NRC, 2006).<sup>4</sup>

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<sup>3</sup> Reviews of the research on the economics of military manpower are provided by Sandler and Hartley (1995), Warner and Asch (1995), and Warner et al. (2007).

<sup>4</sup> Economic historians have extensively studied the historic data on weight and height of conscripts and recruits, for example using them to track long-term trends in standards of living and health; see e.g. Komlos (1987) and Costa (1993, 2004).

The exact standards for weight have evolved continuously since they were first implemented (Johnson, 1997).

Today, the DoD mandates that each military service enforce standards for recruiting that include weight-for-height limits and maximum percent body fat (U.S. DoD, 2004).<sup>5</sup> Although the DoD provides general guidance, each service can determine its own minimum and maximum weight and percent body fat limits for enlistment (NRC, 2006; Yamane, 2007). Current weight-for-height and percent body fat standards for enlistment in active duty forces are listed in Appendix Table A (Army), Appendix Table B (Navy), Appendix Table C (Air Force), and Appendix Table D (Marine Corps). There is considerable variability across the services on several dimensions. The weight-for-height standards of the Army and Marine Corps vary with age (permitting older recruits to be heavier), whereas the Navy and Air Force have a single set of standards that applies to all ages. The Air Force has a single set of weight-for-height standards that applies to both men and women, but the Army, Navy, and Marine Corps have gender-specific standards of weight-for-height. For men, the Marine Corps has the most lenient weight-for-height standards, perhaps to allow for more muscular recruits. For women, weight-for-height standards are strictest in the Army and Marine Corps. Weight-for-height standards are expressed in pounds for a given height in inches, but they are easily converted to BMI. Across the services, maximum allowable BMI is generally in the range of 26-28 for men (the Marine Corps is the exception, allowing BMI as high as 31) and 25-27 for women. The Navy is the only service with no minimum weight requirement.

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<sup>5</sup> All military services also have a set of weight standards for those already in the service that are equal to, or more stringent than, those applied to new recruits (IOM, 2004).

The services also differ in the range of acceptable heights. Acceptable heights are 58-80 inches for the Army<sup>6</sup>, Air Force, and Marine Corps, but the Navy accepts both shorter and taller recruits, with an acceptable range of 51-86 inches.

There is also variation across the services in the enlistment standards for percent body fat. Those of the Army, Navy, and Air Force rise with age, whereas the Marine Corps has a single percent body fat standard for all ages. Each service permits a higher percent body fat for women than men. The maximum allowable percent body fat is lowest in the Marine Corps, which allows no higher than 18% for men and 26% for women. In contrast, the maximum allowable percent body fat by the Army increases with age from 26% to 30% for men and 32% to 36% for women. Despite these substantial differences in standards across services, the National Research Council notes that “There is no rationale given for this variability” (NRC, 2006, p. 117).

Each service has a unique eligible active duty enlistment age range, although none permit those under age 17 to enlist.<sup>7</sup> The allowable age ranges are 17-42 years for Army, 17-34 for Navy, 17-27 for Air Force, and 17-28 for Marine Corps.

Applicants to the military receive medical examinations at military entrance processing stations (MEPS). Each of the four services uses a two-stage process to screen weight and body composition (NRC, 2006). The first stage is to measure weight and height; if the applicant is in the range of acceptable weight-for-height, then no further screening is required. If the applicant exceeds the maximum weight-for-height, then percent body fat is assessed using height and the circumferences of some combination of the abdomen, waist, hip, and neck (the measurement sites vary by service). If the applicant’s percent body fat is in the acceptable range, then the maximum weight-for-height requirement is waived and the applicant is classified as meeting the

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<sup>6</sup> The Army’s range of acceptable heights is 58-80 inches for women, but 60-80 inches for men. The Air Force and Marine Corps range of acceptable heights is 58-80 inches for both women and men.

<sup>7</sup> Potential applicants who are under age 18 must have a parent or guardian's permission to enlist.



requirements. Applicants who exceed both the weight-for-height and percent body fat thresholds are disqualified from enlisting and are encouraged to lose weight and then return to the MEPS for another assessment; under current regulations they must wait four days for every pound of weight to be lost (NRC, 2006). Disqualified applicants have the option of applying for a waiver; each service has its own policy on granting such waivers; see NRC (2006).

**Data: the NHES and NHANES Series (1959-2008)**

This study utilizes the full series of nationally representative, cross-sectional health surveys sponsored by the National Center for Health Statistics of the Centers for Disease Control and Prevention. The National Health Examination Survey, Cycle I (NHES) was conducted during 1959-1962. The National Health and Nutrition Examination Surveys (NHANES) program began with NHANES I, which was conducted 1971-1975, and was followed by NHANES II (1976-1980), NHANES III (1988-1994), and NHANES Continuous (1999-2000, 2001-02, 2003-04, 2005-06, and 2007-08). For information on the sampling frame and methods of data collection in these surveys, see National Center for Health Statistics (1965; 1977; 1994; 2000) and McDowell et al. (1981). In each of these surveys, a nationally representative sample of the U.S. civilian non-institutionalized population was selected using a complex, stratified, multistage probability cluster sampling design. These are the best available data for estimating trends in the number and percent of U.S. military-age civilians who meet the current weight-for-height and percent body fat requirements of the military, as the data are nationally representative, frequently collected over the past five decades, include demographic information such as age and gender, and, most importantly, contain measurements of weight, height, and other anthropometrics that can be used to calculate percent body fat.

Each NHES and NHANES survey included physical examinations conducted in a specially-designed and equipped mobile examination center where a scientific team including a physician and medical and health technicians measured weight, height, and skinfold thickness at the tricep and subscapular region (which is below the shoulder blade). Additional measures of fatness were recorded in certain surveys, but the only fatness measures that were collected consistently from NHES until NHANES 2007-08 are weight, height, and the two measures of skinfold thickness.

The maximum weight that could be measured was not binding in NHES, and was 400 pounds (182 kg) in NHANES I and II. In NHANES III it was again not binding and in NHANES Continuous it was 440 kg (968 pounds). The top-coding of weight does not affect our classification of individuals, as everyone with the maximum weight -- regardless of height -- is not weight eligible for enlistment in the military.<sup>8</sup>

Skinfold thickness at the tricep and subscapular region were assessed using calipers. The NHES and NHANES medical technicians were trained in measuring skinfold thicknesses to ensure accuracy and reliability (National Center for Health Statistics, 2000). The NHANES III and NHANES Continuous noted when a skinfold exceeded the capacity of the calipers. We recode the skinfold size of such individuals to the maximum caliper size, but this top-coding does not affect estimates of eligibility for enlistment in the military because such individuals are not eligible whether their skinfold is set equal to the maximum caliper size or an even larger number.<sup>9</sup> In addition to recording whether the skinfold exceeded the maximum caliper size, the

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<sup>8</sup> The tallest height listed in any of the military standards is 86 inches and the maximum allowable weight for that height is 263 pounds, which is well below the top-coding of weight in the NHES or NHANES.

<sup>9</sup> The percentage of our analysis sample with tricep skinfolds larger than the maximum caliper size is as follows: 1.78% in NHANES III and from 3.08% to 4.91% in each of the five surveys in NHANES Continuous. The percentage of our analysis sample with subscapular skinfolds larger than the maximum caliper size is as follows: 2.46% in NHANES III, 4.26% in NHANES 1999-2000, 1.41% in NHANES 2001-02, 1.7% in NHANES 2003-04, 1.85% in NHANES 2005-06, and 2.26% in NHANES 2007-08.

NHANES III and NHANES Continuous indicated if the examiner could not obtain a measurement (presumably for reasons other than the skinfold exceeding the maximum caliper size). When the skinfold could not be obtained, we impute it separately by sex using the other skinfold thickness (either tricep or subscapular), measured height and weight, age, age squared, race, and ethnicity; this prediction equation is based on respondents with complete information.<sup>10</sup> These regression models explain between 54.87% and 78.54% of the variance in skinfolds, implying that the imputation procedure provides reasonable predictions for missing skinfolds.

Skinfold thicknesses at the tricep and subscapular region are used to calculate body density using the equations in Durnin and Womersley (1974). Body density is then used to calculate percent body fat (Siri, 1956; Durnin and Womersley, 1974).

All analyses exclude pregnant women and (for the surveys that provide such information) women who were pregnant in the past year.<sup>11</sup> For each service, we examine only those civilians who are age-eligible to enlist: those aged 17-42 for the Army, 17-34 for the Navy, 17-27 for the Air Force, and 17-28 for the Marine Corps. After excluding respondents that did not provide valid responses to all survey items of interest the final combined sample size is 34,994.<sup>12</sup>

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<sup>10</sup> The percentage of our analysis sample for whom tricep skinfold thickness could not be obtained was 0.58% in NHANES III, 0.42% in NHANES 1999-2000, 1.18% in NHANES 2001-02, 1.15% in NHANES 2003-04, 1.18% in NHANES 2005-06, and 0.71% in NHANES 2007-08. The percentage of our analysis sample for which subscapular skinfold thickness could not be obtained was 3.12% in NHANES III, 9.57% in NHANES 1999-2000, 11.68% in NHANES 2001-02, 10.95% in NHANES 2003-04, 13.81% in NHANES 2005-06, and 11.94% in NHANES 2007-08.

<sup>11</sup> We exclude from the sample women who are currently pregnant (for each survey) and, when known, women who were pregnant in the past two years (NHANES III) or one year (NHANES I and II).

<sup>12</sup> Final analysis sizes in each survey are: 3,414 for NHES; 6,545 for NHANES I; 5,464 for NHANES II; 7,233 for NHANES III; 2,393 for NHANES 1999-2000; 2,628 for NHANES 2001-02; 2,446 for NHANES 2003-04; 2,484 for NHANES 2005-06; and 2,387 for NHANES 2007-08.

## Methods

In order to estimate the number and percent of military-age Americans who meet the military's enlistment standards for weight-for-height and percent body fat, we use the military's two-stage process. First, we compare the subject's measured weight and height to the active duty enlistment standards of a specific armed service (e.g. Army). A subject who is shorter than the minimum height or taller than the maximum height is coded as not meeting the standard. If the subject is in the range of acceptable weight-for-height, then the subject is classified as meeting the standard. A subject whose weight is below the minimum weight-for-height is coded as not meeting the standard; percent body fat is not relevant if the subject is underweight. If the subject's weight-for-height exceeds the maximum, then the subject's percent body fat is compared to the maximum threshold for that service. If the subject's percent body fat is less than the maximum allowable, then she is classified as meeting the standard. Subjects who exceed both the weight-for-height and percent body fat thresholds are coded as not meeting the standards. This process is followed for all four armed services (Army, Navy, Air Force, Marine Corps) using only the civilians who are age-eligible to enlist in that service.<sup>13</sup>

Population sample weights for the sample that underwent medical examinations are used when estimating the percent of military-age respondents who meet each armed service's standards in each survey: NHES, NHANES I, NHANES II, NHANES III, and NHANES Continuous. We test the hypothesis of equality across surveys (and, therefore, across time) in these estimates.

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<sup>13</sup> We are unable to examine trends in eligibility to enlist in the Coast Guard because the Coast Guard standards are based in part on wrist circumference -- a proxy for body build -- which is not available in the NHES or NHANES surveys.

We use the sampling weights for those who underwent medical examinations to estimate the total number of Americans meeting, and not meeting, the enlistment standards for weight and percent body fat.

We also examine the personal characteristics that predict the probability of meeting the current active duty enlistment weight and body fat standards by estimating gender-specific maximum likelihood probit models using the most recent data, the NHANES Continuous (1999-2008). Specifically, we estimate probit regressions in which the dependent variable is an indicator for whether the subject satisfies the weight and body fat enlistment standards of a particular service. Regressors include: age (20-24; 25-29; 30-34; 35-39; and 40-42 with 17-19 as the omitted category), real family income (\$0-4,999; \$5,000-9,999; \$10,000-14,999; \$15,000-19,999; \$20,000-24,999; \$25,000-34,999; \$45,000-54,999; \$55,000-64,999; \$65,000-74,999; and \$75,000+, with \$35,000-44,999 as the omitted category)<sup>14</sup>, education (less than high school, some college, and college graduate, with high school as the omitted category), marital status (divorced/widowed/separated and never married, with married as the omitted category), race/ethnicity<sup>15</sup> (black, Hispanic, and other, with white as the omitted category), and survey fixed effects (NHANES 1999-2000 as the omitted category). We estimate the reduced-form body fatness production function in equation (1):

$$(1) \quad \Pr(M_{it} = 1) = \Phi(\alpha_0 + \alpha_1'X_{it} + \alpha_2'D_t) + \varepsilon_{it}$$

Where  $M_{it}$  is an indicator for meeting current active duty enlistment standards for weight and body fat in a specific military service for individual  $i$  in survey  $t$ ,  $X_{it}$  is a vector of personal

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<sup>14</sup> The NHANES 1999-2008 provides family income in categorical form. To account for inflation during this period the categorical variables were converted into a pseudo-continuous variable by assigning the mid-point to each category, the Bureau of Labor Statistics' Consumer Price Index was then used to convert all values to 2007 dollars, and the inflation adjusted family income was converted back to an 11 category variable.

<sup>15</sup> NHES and NHANES I, II, and III race and ethnicity information is provided in four mutually exclusive categories: white, black, Hispanic, and other. For consistency we use these categories in all survey years.

characteristics for individual  $i$  in survey  $t$ ,  $D_t$  is a vector of survey fixed effects,  $\varepsilon_{it}$  is a mean zero normally distributed error term, and the  $\alpha$ 's are the parameters to be estimated.  $\Phi(\cdot)$  is the CDF of the normal distribution. In all regressions, we use the sampling weights for those who underwent medical examinations. As recommended by the NHES and NHANES, standard errors are clustered around the primary sampling unit. For ease of interpretation, we calculate the marginal effect for each individual and report the average marginal effect along with the probit coefficient in all production functions. We report standard errors associated with the probit coefficients. Statistical analyses are conducted using Stata for Windows software version 11 (StataCorp, 2009).

## Results

The percent of age-eligible U.S. civilians who satisfy military active duty enlistment requirements for weight and body fat, over time, are listed in Tables 1A (Army, men), 1B (Army, women), 2A (Navy, men), 2B (Navy, women), 3A (Air Force, men), 3B (Air Force, women), 4A (Marine Corps, men), and 4B (Marine Corps, women). Each row of these tables corresponds to a specific survey conducted in certain years: NHES (conducted 1959-62), NHANES I (1971-75), NHANES II (1976-80), NHANES III (1988-94), and the various NHANES Continuous surveys (1999-2000, 2001-02, 2003-04, 2005-06, and 2007-08). Graphs of the percent satisfying enlistment standards for weight and fat, over time, are provided in Figure 1 for men and Figure 2 for women.<sup>16</sup>

For each military service (Army, Navy, Air Force, Marine Corps) and for both men and women, the percent of military-age civilians who meet the service-specific weight and body fat

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<sup>16</sup> In all Figures, data points are placed at the median year of the survey for NHES I and NHANES I, II, and III, and at the first of the two years of the survey for NHANES Continuous.

requirements dropped significantly between the earliest (1959-62) and the most recent (2007-08) surveys. For example, Table 1A, column 4, shows that the percentage of age-eligible (i.e. 17-42 years) male civilians who satisfy the Army's weight-for-height and percent body fat requirements declined from 92.02% in 1959-62 to 85.17% in 2007-08, which is a decrease of 6.85 percentage points or 7.45%, which is statistically significant. The final column in Table 1A indicates that the percentage of male civilians who are both too heavy and too fat to enlist in the Army more than doubled, from 5.55% in 1959-62 to 11.70% in 2007-08. In the most recent data (2007-08), more than three times as many males fail the Army's enlistment standards for being both overweight and overfat (11.70%) than fail them for being underweight (3.13%).

Patterns for men are similar for the other services. Between 1959-62 and 2007-08, the percent of age-eligible men who satisfy both the weight-for-height and percent body fat requirements fell by 7.45% for the Army (Table 1A, column 4), 9.82% for the Navy (Table 2A, column 4), 11.90% for the Air Force (Table 3A, column 4), and 7.21% for the Marine Corps (Table 4A, column 4); each of these declines is statistically significant. Between 1959-62 and 2007-08, the percentage of age-eligible men who are both overweight and overfat and are thus disqualified from enlistment rose 110.91% for the Army (Table 1A, final column), 99.65% for the Navy (Table 2A, final column), 91.04% for the Air Force (Table 3A, final column), and 131.61% for the Marine Corps (Table 4A, final column).

Figure 1 shows the variation over time in the percent of male military-age civilians who satisfy each service's enlistment requirements for weight-for-height and percent body fat. Historically, the largest percentage of military-age civilian men satisfy the current weight-for-height and percent body fat requirements of the Marine Corps and the smallest percentage satisfy the current requirements of the Air Force. As of 2007-08, 88.45% of military-age civilian men

satisfy the weight-for-height and percent body fat requirements of the Marine Corps (see Table 4A, column 4) and 78.09% satisfy the requirements of the Air Force (see Table 3A, column 4).

For each service, the percentage of the population that satisfies the enlistment standards for weight-for-height and percent body fat has declined more for women than men. For example, Table 1B, column 4, shows that the percentage of age-eligible (i.e. 17-42 years) female civilians who satisfy the Army's weight-for-height and percent body fat requirements declined from 78.14% in 1959-62 to 59.54% in 2007-08, which is a decrease of 18.59 percentage points or 23.80%, which is statistically significant. The final column in Table 1B indicates that the percentage of female civilians who are both too heavy and too fat to enlist in the Army more than tripled, from 11.46% in 1959-62 to 34.65% in 2007-08. In the most recent data (2007-08), more than six times as many females fail the Army's enlistment standards for being both overweight and overfat (34.65%) than fail them for being underweight (5.14%).

Patterns for women are similar for the other services. Between 1959-62 and 2007-08, the percent of age-eligible women who satisfy both the weight-for-height and percent body fat requirements fell by 23.8% for the Army (Table 1B, column 4), 25.24% for the Navy (Table 2B, column 4), 21.38% for the Air Force (Table 3B, column 4), and 27.09% for the Marine Corps (Table 4B, column 4); each of these declines is statistically significant. Between 1959-62 and 2007-08, the percentage of age-eligible women who are both overweight and overfat and are thus disqualified from enlistment rose 202.21% for the Army (Table 1B, final column), 311.15% for the Navy (Table 2B, final column), 368.87% for the Air Force (Table 3B, final column), and 269.93% for the Marine Corps (Table 4B, final column). Increases in overweight and overfat among women explain more than 100% of the decline in eligibility because over the same period the percentage of women who are disqualified for being underweight fell by 46-48%.



Figure 2 shows the variation over time in the percent of female military-age civilians who satisfy each service's enlistment requirements for weight-for-height and percent body fat. Historically, the largest percentage of military-age civilian women satisfy the current weight-for-height and percent body fat requirements of the Navy and the smallest percentage satisfy the current requirements of the Marine Corps. As of 2007-08, 69.15% of military-age civilian women satisfy the weight-for-height and percent body fat requirements of the Navy (see Table 2B, column 4) and 54.07% satisfy the requirements of the Marine Corps (see Table 4B, column 4). A comparison of Figures 1 and 2 shows that far smaller percentages of civilian women than civilian men meet current enlistment standards for weight and fat.

We calculate the total number of military-age men and women who would be disqualified from enlistment for failing to satisfy current weight and fat enlistment standards; results are listed in Table 5A for the Army, Table 5B for the Navy, Table 5C for the Air Force, and Table 5D for the Marine Corps. In each table, the upper panel is for men and the lower panel is for women. As of the most recent data (2007-08), the number of age-eligible civilian American men who exceed both the weight-for-height and percent body fat enlistment standards of the armed services was 5.7 million for the Army, 6.1 million for the Navy, 3.4 million for the Air Force, and 2.4 million for the Marine Corps. (Note that these numbers differ across services because of different standards regarding age as well as weight-for-height and percent body fat.) For each service, a far greater number of women than men exceed both the weight-for-height and percent body fat enlistment standards; in 2007-08, the number of women exceeding the standards was: 16.5 million for the Army, 9.8 million for the Navy, 5.9 million for the Air Force, and 7.7 million for the Marine Corps.

We investigate the correlates of meeting current active duty enlistment standards for weight and body fat. Tables 6A and 6B report the results for men and women of probit regressions of meeting the enlistment standards (that is, the dependent variable equals one if the respondent satisfies the requirements for weight-for-height and percent body fat). Models are estimated using data from the NHANES Continuous (1999-2008) for those who are age-eligible to enlist in the particular service<sup>17</sup>. There are separate columns for each armed service. Averages of individual marginal effects are reported in square brackets. Table 6A indicates that, for men, those in the lowest category of family income (0-\$4,999) are 8.12 percentage points more likely to meet the weight and fat standards of the Army, 8.39 percentage points more likely to meet those of the Navy, 10.12 percentage points more likely to meet those of the Air Force, and 8.02 percentage points more likely to meet those of the Marine Corps. Among men, college graduates are more likely than high school graduates with no college to meet the weight-for-height and body fat requirements; specifically: 4.13 percentage points more likely to meet those of the Army, 10.48 percentage points more likely to meet those of the Air Force, and 11.11 percentage points more likely to meet those of the Marine Corps. Men who have never been married are 3.51 percentage points more likely to meet the weight and body fat standards of the Navy and 3.26 percentage points more likely to meet those of the Marine Corps. Relative to white men, African American men are 2.39 percentage points less likely to meet the weight and fat standards of the Army, and Hispanic men are 3.47 percentage points more likely to meet the standards of the Army and 4.79 percentage points more likely to meet the standards of the Marine Corps.

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<sup>17</sup> Observations with missing information on income, education, and marital status are dropped from the analysis sample; this sample is slightly smaller than the sample used in the estimation of percent and number eligible for military service.

Results for women are reported in Table 6B. For women, there is a consistent negative relationship between age and the probability of meeting enlistment standards for weight and body fat. For example, consider the standards for the Army. Relative to women aged 17-19 years, those who are 20-24 are 6.02 percentage points less likely, those who are 25-29 are 14.04 percentage points less likely, those who are 30-34 are 12.6 percentage points less likely, those who are 35-39 are 10.71 percentage points less likely, and those who are 40-42 are 13.25 percentage points less likely, to meet the standards. Women in the highest income category (\$75,000 a year and higher) are 7.64 percentage points more likely to meet the weight-for-height and percent body fat standards of the Navy and 8.68 percentage points more likely to meet those of the Marine Corps. These findings are consistent with the negative correlation between income and body weight among women in the U.S. (see, e.g., McLaren, forthcoming). Relative to female high school graduates with no college, female college graduates are between 11.29 and 16.20 percentage points more likely to meet the weight-for-height and body fat standards of each service. Compared to white females, African-American females are between 14.73 and 16.70 percentage points less likely to meet the weight and body fat standards of each service, and Hispanic females are between 4.32 and 7.29 percentage points less likely to meet the standards of the Navy, Air Force, and Marine Corps.

### **Extensions**

We pursue two extensions. First, we examine several historic sets of weight standards for the Army. Second, we briefly discuss results for the military reserves, National Guard, and military academies.

This paper focuses on the current active duty enlistment standards of the armed services. However, we have located four historic sets of Army active duty enlistment standards for weight and body fat: those issued in 1961, 1969, 1976, and 1991. The 1991 regulations were the first to include a percent body fat maximum; earlier regulations relied solely on weight-for-height. (The Army standards used earlier in the paper were issued in 2007.) A comparison of the four historic sets of standards reveals that weight-for-height standards became much more lenient in 1991. In 2007-08, roughly 85-87% of military-age American males met the current (2007) and 1991 Army standards, but that percentage would be roughly 79-80% if the 1976, 1969, or 1961 weight-for-height standards had been in place. The trend in the percent of American men who would satisfy each set of Army weight-for-height standards is shown in Figure 3. The decrease in eligibility we document in Tables 1A and in Figure 1 would have been even greater if the military had not relaxed its standards in 1991.

In addition to the standards used in this paper, which apply to enlistment for active duty, separate standards for weight and body fat exist for the military reserves, the National Guard (Army and Air), and the three major military academies (i.e. the Army's United States Military Academy at West Point, New York; the United States Naval Academy at Annapolis, Maryland; and the United States Air Force Academy at Colorado Springs, Colorado). We find that the percentage of military-age civilians who meet each of these sets of standards has fallen significantly and substantially between 1959-62 and 2007-08. For the sake of conciseness we omit tables and detailed discussion of these results, but they are available upon request.

## **Limitations**

The limitations of this paper include the following. A recruit who fails to pass the weight-for-height and percent body fat standards can petition to be re-measured at a later date. We are unable to determine which rejected subjects in our sample might have been able to “make weight” at a later date. We estimate body fat using skinfold thicknesses at the tricep and subscapular regions, whereas the services measure it at a variety of other sites such as abdomen, waist, hip and neck (NRC, 2006); however, each is considered an accurate measure of body fat (Heymsfield et al., 2004). We examine only the standards regarding weight-for-height and percent body fat, whereas many other factors, such as standardized test scores and performance on tests of physical fitness determine whether a recruit is eligible for enlistment. Thus, our estimates of the number of civilians that meet the standards for weight-for-height and percent body fat are greater than the number that would pass all military enlistment standards. However, the purpose of this paper is not to estimate the number of civilians who pass all of the military enlistment standards, but to document how rising obesity disqualifies increasing numbers of civilians from military enlistment.

## **Discussion**

The high and rising prevalence of obesity represents a substantial challenge for military recruitment. The percentage of civilian military-age men and women who satisfy military enlistment standards for weight-for-height and percent body fat has fallen considerably since 1959. For example, between 1959-62 and 2007-08, the percentage of civilians aged 17-42 years who exceed the Army’s enlistment standards for weight and body fat has risen by 110.91% for men and 202.21% for women. As of 2007-08, there were 5.7 million men and 16.5 million

women between the ages of 17 and 42 who exceeded the Army's enlistment standards for weight and body fat. As a result, the rise in obesity among the civilian population "may pose significant problems for national defense" (Yamane, 2007, p. 1163).

The implications of the rise in obesity for military recruitment depend in part on the number of military recruits needed. If the U.S. completes Operation New Dawn in Iraq and Operation Enduring Freedom in Afghanistan and downsizes its military, the impact will be less than if an additional major threat or conflict arises that requires a substantial expansion of the military, in which case rising obesity may represent an even greater obstacle to recruiting a sufficient number of high quality candidates, particularly among females.

The problem would be particularly acute if the U.S. was forced by wartime demands to return to a system of conscription or draft that sought to enlist a high percentage of civilians. Under conscription, military enlistment standards and exemptions can have the unintended consequence of incentivizing certain behaviors in order to avoid military service. For example, the Vietnam-era draft, by exempting those attending college, increased college attendance by 4 to 6 percentage points (Card and Lemieux, 2001). Also during the Vietnam draft, a removal of the exemption for married childless men but retention of the exemption for married men with children led to a spike in fertility (Kutinova, 2009). Johnson (1997) contends that, historically, some potential draftees sought to gain weight to disqualify themselves from military service. Yamane (2007) argues that the rise in weight in the civilian population implies that there is a large number of potential draftees close to the maximum allowable weight, for whom it would be relatively easy to intentionally gain a sufficient amount of weight to avoid military service.

The percentage of military-age civilians who meet weight-for-height and body fat standards decreased considerably more for women than men. Although women constitute the

minority of each U.S. armed service, the percentages are nontrivial; women represent 6.2% of the Marine Corps, 13.4% of the Army, 14.8% of the Navy, and 19.4% of the Air Force (U.S. Census Bureau, 2010). However, that is subject to change. When engaged in wars that are intense or long in duration, nations tend to enlist individuals previously thought less suited to service. For example, prior to 1860, the enlistment of large numbers of African Americans in the U.S. armed forces was never seriously considered but that changed with the demands of the Civil War (McPherson, 1988). Several nations, including Israel, require mandatory military service of women (Poast, 2006). Future threats or conflicts could lead the U.S. to enlist large numbers of women in its armed forces. Thus, rising obesity among women, not just that among men, represents a concern for national security.

A simplistic response is to relax the enlistment standards to allow heavier and fatter recruits into the military. However, high weight and body fat have been linked to worse job performance in military occupations (IOM 1990, 2004; Naghii, 2006), and cost the military billions in job absenteeism and health care spending (Dall et al., 2007). The IOM reports that, of the recruits who exceeded the weight-for-height standards but subsequently entered the military because they passed the standards later or received a waiver, 80% left the military before completing their first term of enlistment but after the expenditure of training costs (IOM, 2004). Thus, relaxing the standards could entail substantial costs. It is beyond the scope of this study to calculate the optimal weight standards from a cost-benefit perspective, but that is an important direction for future research.

Our probit results indicate that in recent years (1999-2008), African American females are between 14.73 and 16.70 percentage points less likely than white females to meet the weight and body fat standards of the military services. In addition, Hispanic females are between 4.32

and 7.29 percentage points less likely than white females to meet the weight and body fat standards of the Navy, Air Force, and Marine Corps. African American males are 2.39 percentage points less likely than white males to satisfy the weight and body fat standards of the Army. These disparities represent a substantial challenge for the U.S. military, which actively seeks to recruit a labor force that is representative of the nation but has experienced declining enlistments by minorities, especially African-Americans (Asch et al., 2009).

These implications for military recruitment represent an underappreciated cost of the obesity epidemic, and thus represent an additional reason for the U.S. government to invest in prevention of obesity. Cost-effective school-based interventions to prevent childhood obesity have been identified (Wang et al., 2003; Brown et al., 2007; Cawley, 2007). In addition, both the Federal and state governments can mandate that private health insurance plans cover cost-effective methods of preventing and treating youth obesity (Homer and Simpson, 2007; Cawley 2010) and can cover such methods in their Medicaid programs. There is a precedent for concerns about military readiness leading to government policies to reduce obesity. Singapore, which is ruled by a military government and has universal male conscription, became concerned about rising obesity among military conscripts and in response implemented in 1992 a broad campaign to reduce youth obesity (Walsh, 2004). Even in the U.S. there is precedent for the military advocating policies to ensure healthy weight among youths; the Mission: Readiness (2010) report notes that, after World War II, General Lewis Hershey, the Director of the Selective Service, convinced Congress to pass the National School Lunch Act "...as a way to improve the nutrition of America's children, increase their height and weight, and ensure America's national security" (Mission: Readiness, 2010, p. 1). Ironically, the modern school lunch program has been identified as a contributing factor to childhood obesity (e.g.,



Schanzenbach, 2009). As a result, retired generals and admirals are now calling for the removal of high-calorie, low-nutrient foods from schools and for improving the quality of the school lunch program (Mission: Readiness, 2010).

The trends documented in this paper suggest that retaining already-fit members of the military may be increasingly cost-effective relative to finding and recruiting civilians who meet military weight and body fat requirements. A direction for future research is to examine whether cost effectiveness considerations justify shifting resources away from recruitment and toward retention.

The trends documented in this paper also suggest that the military may need to increasingly engage in factor substitution. As obesity raises the cost of recruiting an additional soldier who meets military weight requirements (and as excess fatness lowers the marginal product of labor), it may be cost-saving to substitute away from labor and toward capital. The military has recently engaged in such factor substitution, e.g. moving from manned to unmanned aerial vehicles (e.g. Predator drones); additional substitution of capital for labor could help the military deal with a shrinking pool of high-quality recruits.

Another possibility is to substitute not from labor to capital but from one type of labor to another type of labor. During the War on Terror, the U.S. military has increasingly outsourced activities to private military companies, which can recruit from a broader, international, labor pool (Singer, 2003). Though perhaps repugnant to some (Roth, 2007), such outsourcing of military functions could alleviate the burden on the U.S. military to find a large number of fit military recruits.

An ongoing challenge for the military is how to accurately measure fitness for service. Initially the military used weight-for-height, in part because it is easy to assess, but it is a noisy

measure of fatness (Cawley and Burkhauser, 2006), and had the undesirable consequence of excluding men with high muscle mass, so the military now admits applicants who exceed the weight-for-height standard as long as their percent body fat is under a certain threshold (Johnson, 1997). Moreover, the services have varying standards of weight-for-height and body fat with no clearly articulated rationale based on difference of needs (NRC, 2006). A direction for future research is to determine the measure of fatness, and the enlistment standards based on that measure of fatness, that are optimal for each service.

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Table 1A. Percent of military-age male civilians who meet and do not meet Army active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6	7	8
	Survey Years	Unweighted N	Meet standards	Do not meet standards	Outside height range	Underweight	Overweight and overfat
NHES I	1959-1962	1637	92.02 (0.98)	7.98 (0.98)	0.00 (0.00)	2.43 (0.48)	5.55 (0.92)
NHANES I	1971-1975	2280	91.62 (0.90)	8.38 (0.90)	0.00 (0.00)	4.00 (0.57)	4.38 (0.59)
NHANES II	1976-1980	2828	89.73 (0.73)	10.27 (0.73)	0.13 (0.07)	3.98 (0.42)	6.16 (0.49)
NHANES III	1988-1994	3871	89.82 (0.77)	10.18 (0.77)	0.18 (0.11)	2.73 (0.50)	7.27 (0.74)
NHANES 99	1999-2000	1230	84.67 (1.33)	15.33 (1.33)	0.00 (0.00)	3.63 (0.73)	11.70 (1.36)
NHANES 01	2001-2002	1380	85.63 (0.54)	14.37 (0.54)	0.00 (0.00)	3.65 (0.48)	10.72 (0.64)
NHANES 03	2003-2004	1295	85.98 (0.93)	14.02 (0.93)	0.02 (0.02)	3.61 (0.65)	10.40 (1.21)
NHANES 05	2005-2006	1305	85.85 (1.56)	14.15 (1.56)	0.05 (0.05)	3.25 (0.78)	10.85 (1.36)
NHANES 07	2007-2008	1219	85.17 (1.49)	14.83 (1.49)	0.00 (0.00)	3.13 (0.63)	11.70 (1.31)
Percentage Point Change Between NHES I and NHANES 07	--	--	-6.85	6.85	0.00	0.70	6.15
Percent Change Between NHES I and NHANES 07	--	--	-7.45	85.92	0.00	28.82	110.91
<i>p</i> -value <sup>2</sup>	--	--	0.00	0.00	--	0.04	0.00

Notes: Percent eligible and ineligible is calculated by applying current Army weight standards to historical data. See Appendix Table A for current Army enlistment weight standards. Eligible age range is 17-42 for enlistment in Army active duty. Historical sampling weights and adjustment for strata employed. Standard errors clustered around primary sampling unit are reported in parentheses. Observations with missing information and pregnant women excluded from the analysis sample.

<sup>2</sup>*t*-test for difference in means between NHES I and NHANES 07.

Table 1B. Percent of military-age female civilians who meet and do not meet Army active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6	7	8
	Survey Years	Unweighted N	Meet standards	Do not meet standards	Outside height range	Underweight	Overweight and overfat
NHES I	1959-1962	1777	78.14 (0.92)	21.86 (0.92)	0.55 (0.16)	9.84 (0.73)	11.46 (0.92)
NHANES I	1971-1975	4265	71.73 (0.84)	28.27 (0.84)	0.55 (0.14)	11.80 (0.57)	15.91 (0.64)
NHANES II	1976-1980	2636	70.92 (0.94)	29.08 (0.94)	0.54 (0.16)	9.95 (0.58)	18.59 (0.89)
NHANES III	1988-1994	3362	64.27 (1.47)	35.73 (1.47)	0.47 (0.14)	8.14 (0.70)	27.12 (1.38)
NHANES 99	1999-2000	1163	61.38 (2.75)	38.62 (2.75)	0.25 (0.12)	6.86 (1.25)	31.51 (2.29)
NHANES 01	2001-2002	1248	64.35 (1.58)	35.65 (1.58)	0.85 (0.34)	6.27 (0.76)	28.52 (1.92)
NHANES 03	2003-2004	1151	60.83 (2.30)	39.17 (2.30)	0.33 (0.12)	5.88 (0.93)	32.96 (2.51)
NHANES 05	2005-2006	1179	64.17 (2.00)	35.83 (2.00)	0.55 (0.23)	6.45 (1.02)	28.83 (1.87)
NHANES 07	2007-2008	1168	59.54 (1.94)	40.46 (1.94)	0.67 (0.25)	5.14 (0.66)	34.65 (2.11)
Percentage Point Change Between NHES I and NHANES 07	--	--	-18.59	18.59	0.12	-4.71	23.18
Percent Change Between NHES I and NHANES 07	--	--	-23.80	85.05	21.48	-47.81	202.21
<i>p</i> -value <sup>2</sup>	--	--	0.00	0.00	0.14	0.00	0.00

Notes: Percent eligible and ineligible is calculated by applying current Army weight standards to historical data. See Appendix Table A for current Army enlistment weight standards. Eligible age range is 17-42 for enlistment in Army active duty. Historical sampling weights and adjustment for strata employed. Standard errors clustered around primary sampling unit are reported in parentheses. Observations with missing information and pregnant women excluded from the analysis sample.

<sup>2</sup>*t*-test for difference in means between NHES I and NHANES 07.

Table 2A. Percent of military-age male civilians who meet and do not meet Navy active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6	7
	Survey Years	Unweighted N	Meet standards	Do not meet standards	Outside height range	Overweight and overfat
NHES I	1959-1962	1080	91.03 (1.34)	8.97 (1.34)	0.00 (0.00)	8.97 (1.34)
NHANES I	1971-1975	1753	91.03 (0.97)	8.97 (0.97)	0.00 (0.00)	8.97 (0.97)
NHANES II	1976-1980	2221	90.26 (0.71)	9.74 (0.71)	0.00 (0.00)	9.74 (0.71)
NHANES III	1988-1994	2772	87.89 (0.98)	12.11 (0.98)	0.00 (0.00)	12.11 (0.98)
NHANES 99	1999-2000	949	83.69 (2.37)	16.31 (2.37)	0.00 (0.00)	16.31 (2.37)
NHANES 01	2001-2002	1054	82.55 (1.12)	17.45 (1.12)	0.00 (0.00)	17.45 (1.12)
NHANES 03	2003-2004	1034	81.77 (1.89)	18.23 (1.89)	0.00 (0.00)	18.23 (1.89)
NHANES 05	2005-2006	992	82.09 (1.32)	17.91 (1.32)	0.00 (0.00)	17.91 (1.32)
NHANES 07	2007-2008	860	82.08 (1.69)	17.92 (1.69)	0.00 (0.00)	17.92 (1.69)
Percentage Point Change Between NHES I and NHANES 07	--	--	-8.94	8.94	0.00	8.94
Percent Change Between NHES I and NHANES 07	--	--	-9.82	99.65	0.00	99.65
<i>p</i> -value <sup>2</sup>	--	--	0.00	0.00	--	0.00

*Notes:* Percent eligible and ineligible is calculated by applying current Navy weight standards to historical data. See Appendix Table B for current Navy enlistment weight standards. Eligible age range is 17-34 for enlistment in Navy active duty. Historical sampling weights and adjustment for strata employed. Standard errors clustered around primary sampling unit are reported in parentheses. Observations with missing information excluded from the sample. The current Navy enlistment standards do not include a minimum weight and thus there is no column for percent underweight.

<sup>2</sup>*t*-test for difference in means between NHES I and NHANES 07.



Table 2B. Percent of military-age female civilians who meet and do not meet Navy active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6	7
	Survey Years	Unweighted N	Meet standards	Do not meet standards	Outside height range	Overweight and overfat
NHES I	1959-1962	1148	92.50 (0.81)	7.50 (0.81)	0.00 (0.00)	7.50 (0.81)
NHANES I	1971-1975	2977	87.26 (0.76)	12.74 (0.76)	0.00 (0.00)	12.74 (0.76)
NHANES II	1976-1980	1989	85.99 (1.07)	14.01 (1.07)	0.00 (0.00)	14.01 (1.07)
NHANES III	1988-1994	2121	78.99 (1.46)	21.01 (1.46)	0.00 (0.00)	21.01 (1.46)
NHANES 99	1999-2000	868	71.47 (3.07)	28.53 (3.07)	0.00 (0.00)	28.53 (3.07)
NHANES 01	2001-2002	936	72.97 (2.02)	27.03 (2.02)	0.00 (0.00)	27.03 (2.02)
NHANES 03	2003-2004	883	72.66 (2.46)	27.34 (2.46)	0.00 (0.00)	27.34 (2.46)
NHANES 05	2005-2006	905	74.08 (2.42)	25.92 (2.70)	0.00 (0.00)	25.92 (2.70)
NHANES 07	2007-2008	801	69.15 (2.70)	30.85 (2.70)	0.00 (0.00)	30.85 (2.70)
Percentage Point Change Between NHES I and NHANES 07	--	--	-23.35	23.35	0.00	23.35
Percent Change Between NHES I and NHANES 07	--	--	-25.24	311.15	0.00	311.15
<i>p</i> -value <sup>2</sup>	--	--	0.00	0.00	--	0.00

Notes: Percent eligible and ineligible is calculated by applying current Navy weight standards to historical data. See Appendix Table B for current Navy enlistment weight standards. Eligible age range is 17-34 for enlistment in Navy active duty. Historical sampling weights and adjustment for strata employed. Standard errors clustered around primary sampling unit are reported in parentheses. Observations with missing information and pregnant women excluded from the analysis sample. The current Navy enlistment standards do not include a minimum weight and thus there is no column for percent underweight.

<sup>2</sup>*t*-test for difference in means between NHES I and NHANES 07.

Table 3A. Percent of military-age male civilians who meet and do not meet Air Force active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6	7	8
	Survey Years	Unweighted N	Meet standards	Do not meet standards	Outside height range	Underweight	Overweight and overfat
NHES I	1959-1962	594	88.64 (1.86)	11.36 (1.86)	0.00 (0.00)	3.24 (0.65)	8.12 (1.69)
NHANES I	1971-1975	1229	85.68 (1.47)	14.32 (1.47)	0.00 (0.00)	5.65 (0.94)	8.67 (1.09)
NHANES II	1976-1980	1520	86.37 (1.14)	13.63 (1.14)	0.00 (0.00)	5.74 (0.74)	7.89 (0.86)
NHANES III	1988-1994	1690	83.86 (1.28)	16.14 (1.28)	0.01 (0.01)	4.79 (0.98)	11.34 (1.18)
NHANES 99	1999-2000	724	80.60 (2.35)	19.40 (2.35)	0.00 (0.00)	4.33 (0.99)	15.07 (2.48)
NHANES 01	2001-2002	834	75.34 (2.16)	24.66 (2.16)	0.00 (0.00)	7.19 (1.24)	17.48 (1.51)
NHANES 03	2003-2004	789	72.22 (2.66)	27.78 (2.66)	0.03 (0.03)	6.64 (1.33)	21.10 (2.43)
NHANES 05	2005-2006	760	78.94 (2.41)	21.06 (2.41)	0.00 (0.00)	5.94 (1.56)	15.12 (2.08)
NHANES 07	2007-2008	570	78.09 (2.54)	21.91 (2.54)	0.00 (0.00)	6.39 (1.27)	15.52 (1.87)
Percentage Point Change Between NHES I and NHANES 07	--	--	-10.54	10.54	0.00	3.15	7.40
Percent Change Between NHES I and NHANES 07	--	--	-11.90	92.78	0.00	97.13	91.04
<i>p</i> -value <sup>2</sup>	--	--	0.00	0.00	--	0.00	0.00

Notes: Percent eligible and ineligible is calculated by applying current Air Force weight standards to historical data. See Appendix Table C for current Air Force enlistment weight standards. Eligible age range is 17-27 for enlistment in Air Force active duty. Historical sampling weights and adjustment for strata employed. Standard errors clustered around primary sampling unit are reported in parentheses. Observations with missing information excluded from the sample.

<sup>2</sup>*t*-test for difference in means between NHES I and NHANES 07.

Table 3B. Percent of military-age female civilians who meet and do not meet Air Force active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6	7	8
	Survey Years	Unweighted N	Meet standards	Do not meet standards	Outside height range	Underweight	Overweight and overfat
NHES I	1959-1962	678	77.49 (1.39)	22.51 (1.39)	0.40 (0.24)	15.70 (1.20)	6.41 (1.00)
NHANES I	1971-1975	1879	72.16 (1.10)	27.84 (1.10)	0.57 (0.20)	16.63 (0.92)	10.64 (0.84)
NHANES II	1976-1980	1288	77.33 (1.31)	22.67 (1.31)	0.64 (0.24)	12.27 (0.83)	9.76 (0.95)
NHANES III	1988-1994	1222	70.30 (2.19)	29.70 (2.19)	0.92 (0.39)	13.22 (1.65)	15.56 (1.49)
NHANES 99	1999-2000	668	65.05 (2.95)	34.95 (2.95)	0.60 (0.30)	10.48 (2.10)	23.87 (2.28)
NHANES 01	2001-2002	708	60.46 (1.92)	39.54 (1.92)	0.96 (0.56)	9.84 (1.43)	28.74 (2.10)
NHANES 03	2003-2004	669	66.86 (2.52)	33.14 (2.52)	0.53 (0.25)	8.92 (0.90)	23.69 (2.53)
NHANES 05	2005-2006	680	68.78 (2.11)	31.22 (2.11)	0.84 (0.35)	10.23 (1.49)	20.15 (2.24)
NHANES 07	2007-2008	505	60.92 (2.72)	39.08 (2.72)	0.55 (0.31)	8.46 (1.35)	30.06 (2.75)
Percentage Point Change Between NHES I and NHANES 07	--	--	-16.56	16.56	0.15	-7.23	23.65
Percent Change Between NHES I and NHANES 07	--	--	-21.38	73.58	36.14	-46.09	368.87
<i>p</i> -value <sup>2</sup>	--	--	0.00	0.00	0.44	0.00	0.00

Notes: Percent eligible and ineligible is calculated by applying current Air Force weight standards to historical data. See Appendix Table C for current Air Force enlistment weight standards. Eligible age range is 17-27 for enlistment in Air Force active duty. Historical sampling weights and adjustment for strata employed. Standard errors clustered around primary sampling unit are reported in parentheses. Observations with missing information and pregnant women excluded from the analysis sample.

<sup>2</sup>*t*-test for difference in means between NHES I and NHANES 07.

Table 4A. Percent of military-age male civilians who meet and do not meet Marine Corps active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6	7	8
	Survey Years	Unweighted N	Meet standards	Do not meet standards	Outside height range	Underweight	Overweight and overfat
NHES I	1959-1962	646	95.32 (1.05)	4.68 (1.05)	0.00 (0.00)	0.28 (0.20)	4.39 (1.07)
NHANES I	1971-1975	1324	94.62 (0.79)	5.38 (0.79)	0.00 (0.00)	1.16 (0.39)	4.22 (0.59)
NHANES II	1976-1980	1625	95.70 (0.41)	4.30 (0.41)	0.00 (0.00)	1.03 (0.22)	3.27 (0.39)
NHANES III	1988-1994	1842	92.08 (1.14)	7.92 (1.14)	0.01 (0.01)	1.47 (0.51)	6.44 (1.00)
NHANES 99	1999-2000	748	86.22 (2.07)	13.78 (2.07)	0.00 (0.00)	2.65 (0.79)	11.13 (1.75)
NHANES 01	2001-2002	865	87.35 (1.11)	12.65 (1.11)	0.00 (0.00)	1.95 (1.09)	10.70 (1.32)
NHANES 03	2003-2004	820	83.20 (1.73)	16.80 (1.73)	0.03 (0.03)	2.59 (0.56)	14.18 (1.60)
NHANES 05	2005-2006	789	85.02 (2.52)	14.98 (2.52)	0.00 (0.00)	2.26 (0.70)	12.72 (2.35)
NHANES 07	2007-2008	619	88.45 (1.63)	11.55 (1.63)	0.00 (0.00)	1.37 (0.48)	10.17 (1.69)
Percentage Point Change Between NHES I and NHANES 07	--	--	-6.87	6.87	0.00	1.09	5.78
Percent Change Between NHES I and NHANES 07	--	--	-7.21	146.90	0.00	382.78	131.61
<i>p</i> -value <sup>2</sup>	--	--	0.00	0.00	.	0.02	0.00

Notes: Percent eligible and ineligible is calculated by applying current Marine Corps weight standards to historical data. See Appendix Table D for current Marine Corps enlistment weight standards. Eligible age range is 17-28 for enlistment in Marine Corps active duty. Historical sampling weights and adjustment for strata employed. Standard errors clustered around primary sampling unit are reported in parentheses. Observations with missing information excluded from the sample.

<sup>2</sup>*t*-test for difference in means between NHES I and NHANES 07.

Table 4B. Percent of military-age female civilians who meet and do not meet Marine Corps active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6	7	8
	Survey Years	Unweighted N	Meet standards	Do not meet standards	Outside height range	Underweight	Overweight and overfat
NHES I	1959-1962	731	74.16 (1.34)	25.84 (1.34)	0.37 (0.22)	15.38 (1.20)	10.09 (1.20)
NHANES I	1971-1975	2053	67.12 (1.17)	32.88 (1.17)	0.67 (0.21)	16.26 (0.89)	15.95 (0.94)
NHANES II	1976-1980	1403	69.80 (1.41)	30.20 (1.41)	0.74 (0.26)	12.65 (0.81)	16.81 (1.22)
NHANES III	1988-1994	1353	64.15 (1.98)	35.85 (1.98)	0.81 (0.35)	12.59 (1.47)	22.45 (1.65)
NHANES 99	1999-2000	688	55.95 (3.23)	44.05 (3.23)	0.56 (0.28)	9.87 (1.88)	33.63 (2.89)
NHANES 01	2001-2002	736	53.08 (2.21)	46.92 (2.21)	1.29 (0.64)	9.43 (1.39)	36.20 (2.74)
NHANES 03	2003-2004	696	56.18 (2.96)	43.82 (2.96)	0.49 (0.23)	8.66 (0.88)	34.67 (3.07)
NHANES 05	2005-2006	712	58.21 (2.51)	41.79 (2.51)	0.94 (0.36)	9.63 (1.36)	31.22 (2.57)
NHANES 07	2007-2008	535	54.07 (2.50)	45.93 (2.50)	0.52 (0.29)	8.09 (1.28)	37.32 (2.93)
Percentage Point Change Between NHES I and NHANES 07	--	--	-20.09	20.09	0.14	-7.29	27.23
Percent Change Between NHES I and NHANES 07	--	--	-27.09	77.72	38.72	-47.42	269.93
<i>p</i> -value <sup>2</sup>	--	--	0.00	0.00	0.42	0.00	0.00

Notes: Percent eligible and ineligible is calculated by applying current Marine Corps weight standards to historical data. See Appendix Table D for current Marine Corps enlistment weight standards. Eligible age range is 17-28 for enlistment in Marine Corps active duty. Historical sampling weights and adjustment for strata employed. Standard errors clustered around primary sampling unit are reported in parentheses. Observations with missing information and pregnant women excluded from the analysis sample.

<sup>2</sup>*t*-test for difference in means between NHES I and NHANES 07.

Table 5A. Total number of military-age civilians who meet and do not meet Army active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6	7
	Survey Years	Meet standards	Do not meet standards	Outside height range	Underweight	Overweight and overfat
<i>Men</i>						
NHES	1959-1962	24,273,495	2,103,625	0	640,180	1,463,445
NHANES I	1971-1975	32,265,243	2,950,838	0	1,409,638	1,541,200
NHANES II	1976-1980	36,301,781	4,153,095	51,618	1,611,440	2,490,037
NHANES III	1988-1994	43,925,044	4,977,073	86,334	1,335,367	3,555,372
NHANES 99	1999-2000	44,047,768	7,974,813	0	1,886,511	6,088,302
NHANES 01	2001-2002	42,272,424	7,093,883	0	1,803,993	5,289,890
NHANES 03	2003-2004	42,449,568	6,922,534	10,096	1,780,174	5,132,264
NHANES 05	2005-2006	41,658,246	6,864,365	26,381	1,574,559	5,263,425
NHANES 07	2007-2008	41,802,814	7,277,551	0	1,534,469	5,743,082
<i>Women</i>						
NHES	1959-1962	21,538,293	6,026,555	152,983	2,713,580	3,159,992
NHANES I	1971-1975	23,747,628	9,358,338	183,568	3,908,039	5,266,731
NHANES II	1976-1980	26,206,429	10,746,195	198,972	3,678,170	6,869,053
NHANES III	1988-1994	24,681,434	13,719,726	180,232	3,126,280	10,413,214
NHANES 99	1999-2000	29,575,105	18,607,608	118,403	3,306,581	15,182,625
NHANES 01	2001-2002	29,965,625	16,597,408	396,593	2,919,012	13,281,802
NHANES 03	2003-2004	28,581,515	18,406,747	156,768	2,764,276	15,485,703
NHANES 05	2005-2006	28,918,562	16,145,557	247,434	2,905,312	12,992,811
NHANES 07	2007-2008	28,296,266	19,226,566	320,409	2,441,738	16,464,419

*Notes:* Total number of Americans eligible for enlistment is calculated by applying current Army weight standards to historical data. See Appendix Table A for current Army enlistment weight standards. Historical sampling weights employed. Observations with missing information and pregnant women excluded from the analysis sample.

Table 5B. Total number of military-age civilians who meet and do not meet Navy active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6
	Survey Years	Meet standards	Do not meet standards	Outside height range	Overweight and overfat
<i>Men</i>					
NHES	1959-1962	15,766,973	1,554,421	0	1,554,421
NHANES I	1971-1975	24,470,383	2,409,868	0	2,409,868
NHANES II	1976-1980	28,053,638	3,028,629	0	3,028,629
NHANES III	1988-1994	29,391,145	4,051,000	0	4,051,000
NHANES 99	1999-2000	29,101,698	5,673,485	0	5,673,485
NHANES 01	2001-2002	26,068,909	5,510,641	0	5,510,641
NHANES 03	2003-2004	28,111,431	6,266,279	0	6,266,279
NHANES 05	2005-2006	27,263,575	5,946,659	0	5,946,659
NHANES 07	2007-2008	27,839,329	6,076,627	0	6,076,627
<i>Women</i>					
NHES	1959-1962	16,434,423	1,333,299	0	1,333,299
NHANES I	1971-1975	21,055,300	3,073,314	0	3,073,314
NHANES II	1976-1980	23,789,781	3,877,103	0	3,877,103
NHANES III	1988-1994	18,401,626	4,893,990	0	4,893,990
NHANES 99	1999-2000	21,781,845	8,692,984	0	8,692,984
NHANES 01	2001-2002	22,770,875	8,436,820	0	8,436,820
NHANES 03	2003-2004	22,470,801	8,456,527	0	8,456,527
NHANES 05	2005-2006	21,454,430	7,507,284	0	7,507,284
NHANES 07	2007-2008	21,997,369	9,815,180	0	9,815,180

*Notes:* Total number of Americans eligible for enlistment is calculated by applying current Navy weight standards to historical data. See Appendix Table B for current Navy enlistment weight standards. Historical sampling weights employed. Observations with missing information and pregnant women excluded from the analysis sample.

Table 5C. Total number of military-age civilians who meet and do not meet Air Force active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6	7
	Survey Years	Meet standards	Do not meet standards	Outside height range	Underweight	Overweight and overfat
<i>Men</i>						
NHES	1959-1962	8,691,675	1,114,401	0	317,803	796,598
NHANES I	1971-1975	15,635,588	2,613,038	0	1,031,657	1,581,381
NHANES II	1976-1980	17,711,870	2,796,245	0	1,177,522	1,618,723
NHANES III	1988-1994	15,285,912	2,941,909	1,586	872,450	2,067,873
NHANES 99	1999-2000	16,429,284	3,955,489	0	882,677	3,072,812
NHANES 01	2001-2002	15,552,419	5,091,620	0	1,483,572	3,608,048
NHANES 03	2003-2004	15,298,024	5,883,613	5,925	1,407,339	4,470,350
NHANES 05	2005-2006	17,082,457	4,558,168	0	1,285,187	3,272,981
NHANES 07	2007-2008	16,907,160	4,743,219	0	1,383,206	3,360,014
<i>Women</i>						
NHES	1959-1962	8,200,910	2,382,732	42,809	1,661,286	678,637
NHANES I	1971-1975	11,581,553	4,468,105	90,752	2,668,881	1,708,472
NHANES II	1976-1980	13,565,151	3,975,918	112,067	2,152,295	1,711,556
NHANES III	1988-1994	9,137,860	3,859,669	119,492	1,717,863	2,022,315
NHANES 99	1999-2000	12,076,830	6,489,438	111,561	1,945,544	4,432,334
NHANES 01	2001-2002	11,943,310	7,811,070	188,660	1,944,651	5,677,758
NHANES 03	2003-2004	12,688,393	6,288,755	100,549	1,693,157	4,495,049
NHANES 05	2005-2006	12,249,402	5,560,094	149,512	1,822,505	3,588,077
NHANES 07	2007-2008	11,926,663	7,650,280	107,804	1,656,756	5,885,721

*Notes:* Total number of Americans eligible for enlistment is calculated by applying current Air Force weight standards to historical data. See Appendix Table C for current Air Force enlistment weight standards. Historical sampling weights employed. Observations with missing information and pregnant women excluded from the analysis sample.



Table 5D. Total number of military-age civilians who meet and do not meet Marine Corps active duty enlistment standards for weight and percent body fat, by survey

1	2	3	4	5	6	7
	Survey Years	Meet standards	Do not meet standards	Outside height range	Underweight	Overweight and overfat
<i>Men</i>						
NHES	1959-1962	10,101,138	495,532	0	30,171	465,361
NHANES I	1971-1975	18,681,813	1,062,799	0	229,631	833,168
NHANES II	1976-1980	21,103,387	948,150	0	227,981	720,169
NHANES III	1988-1994	18,843,816	1,620,390	1,586	301,219	1,317,585
NHANES 99	1999-2000	18,809,904	3,005,645	0	577,692	2,427,952
NHANES 01	2001-2002	19,407,552	2,810,468	0	433,280	2,377,189
NHANES 03	2003-2004	18,858,924	3,806,712	5,925	586,284	3,214,503
NHANES 05	2005-2006	19,770,193	3,483,085	0	526,382	2,956,702
NHANES 07	2007-2008	20,926,960	2,731,605	0	325,208	2,406,397
<i>Women</i>						
NHES	1959-1962	8,479,227	2,955,026	42,809	1,758,595	1,153,622
NHANES I	1971-1975	11,610,309	5,687,507	116,297	2,812,326	2,758,884
NHANES II	1976-1980	13,443,050	5,816,332	142,761	2,435,625	3,237,946
NHANES III	1988-1994	9,436,255	5,272,848	119,492	1,851,364	3,301,992
NHANES 99	1999-2000	11,126,362	8,761,233	111,561	1,962,225	6,687,448
NHANES 01	2001-2002	11,109,010	9,818,944	269,612	1,972,660	7,576,672
NHANES 03	2003-2004	11,441,104	8,925,257	100,549	1,763,415	7,061,292
NHANES 05	2005-2006	11,101,800	7,968,661	178,966	1,836,389	5,953,306
NHANES 07	2007-2008	11,223,557	9,533,584	107,804	1,678,517	7,747,263

*Notes:* Total number of Americans eligible for enlistment is calculated by applying current Marine Corps weight standards to historical data. See Appendix Table D for current Marine Corps enlistment weight standards. Historical sampling weights employed. Observations with missing information and pregnant women excluded from the analysis sample.

Table 6A. Correlates of meeting military active duty enlistment standards for weight and body fat, men in Continuous NHANES (1999-2008)

	Army (17-42 yrs)	Navy (17-34 yrs)	Air Force (17-27 yrs)	Marine Corps (17-28 yrs)
<i>Age</i>				
20-24 Years	0.1717* (0.0910) [0.0384]	-0.1117 (0.1011) [-0.0283]	0.0467 (0.0958) [0.0142]	-0.0862 (0.1053) [-0.0176]
25-29 Years	0.2522** (0.1191) [0.0564]	-0.0683 (0.1156) [-0.0173]	0.1556 (0.1110) [0.0475]	-0.1055 (0.1386) [-0.0216]
30-34 Years	0.3268*** (0.1140) [0.0731]	-0.3332*** (0.0960) [-0.0843]	--	--
35-39 Years	0.2372** (0.0985) [0.0530]	--	--	--
40-42 Years	0.1527 (0.1139) [0.0341]	--	--	--
<i>Family Income</i>				
0-4,999	0.3633** (0.1453) [0.0812]	0.3315* (0.1734) [0.0839]	0.3317* (0.1728) [0.1012]	0.3925* (0.2095) [0.0802]
5,000-9,999	-0.0986 (0.1774) [-0.0220]	0.0807 (0.1749) [0.0204]	0.0667 (0.2062) [0.0203]	0.0296 (0.2062) [0.0061]
10,000-14,999	-0.0469 (0.1299) [-0.0105]	0.2002 (0.1508) [0.0506]	0.1114 (0.1770) [0.0340]	0.2377 (0.2115) [0.0486]
15,000-19,999	-0.1768 (0.1149) [-0.0395]	0.1246 (0.1299) [0.0315]	-0.0276 (0.1610) [-0.0084]	0.0660 (0.1700) [0.0135]
20,000-24,999	0.1190 (0.1344) [0.0266]	0.0964 (0.1436) [0.0244]	0.1011 (0.1604) [0.0308]	0.2348 (0.1790) [0.0480]

25,000-34,999	-0.0569 (0.1110) [-0.0127]	0.0200 (0.1269) [0.0050]	0.1209 (0.1620) [0.0369]	0.1383 (0.1777) [0.0283]
45,000-54,999	-0.0690 (0.1167) [-0.0154]	-0.1082 (0.1375) [-0.0274]	-0.0322 (0.1616) [-0.0098]	-0.0041 (0.1584) [-0.0008]
55,000-64,999	-0.1552 (0.1263) [-0.0347]	-0.1611 (0.1447) [-0.0407]	-0.0874 (0.1669) [-0.0267]	0.1351 (0.1906) [0.0276]
65,000-74,999	0.0803 (0.1541) [0.0180]	0.0901 (0.1946) [0.0228]	-0.0966 (0.2302) [-0.0295]	-0.0717 (0.2675) [-0.0147]
75,000+	0.1436 (0.1189) [0.0321]	0.1724 (0.1380) [0.0436]	0.2069 (0.1578) [0.0631]	0.2880 (0.1866) [0.0589]
<i>Education</i>				
Less than High School	0.0396 (0.0669) [0.0088]	0.0520 (0.0817) [0.0132]	0.0629 (0.0834) [0.0192]	-0.0552 (0.0938) [-0.0113]
Some College	-0.0872 (0.0696) [-0.0195]	-0.0153 (0.0820) [-0.0039]	0.0154 (0.1025) [0.0047]	0.0538 (0.1150) [0.0110]
College Graduate	0.1849* (0.1011) [0.0413]	0.1751 (0.1169) [0.0443]	0.3438** (0.1659) [0.1048]	0.5435*** (0.1854) [0.1111]
<i>Marital Status</i>				
Divorced	0.0920 (0.1357) [0.0206]	0.1596 (0.1810) [0.0404]	0.1176 (0.3086) [0.0359]	0.4673 (0.3752) [0.0955]
Never Married	0.0309 (0.0656) [0.0069]	0.1386* (0.0777) [0.0351]	0.1140 (0.0851) [0.0348]	0.1594* (0.0892) [0.0326]
<i>Race/Ethnicity</i>				
Black	-0.1069* (0.0622) [-0.0239]	-0.0932 (0.0660) [-0.0236]	-0.0259 (0.0836) [-0.0079]	-0.1305 (0.0932) [-0.0267]

Hispanic	0.1554** (0.0758) [0.0347]	-0.0216 (0.0708) [-0.0055]	0.1006 (0.0943) [0.0307]	0.2342** (0.0962) [0.0479]
Other	-0.0709 (0.1148) [-0.0158]	-0.0827 (0.1533) [-0.0209]	-0.0164 (0.1637) [-0.0050]	0.0118 (0.1723) [0.0024]
<i>Unweighted N</i>	5186	3845	2793	2940

*Notes:* See Appendix Tables for current military enlistment weight standards. Historical sampling weights and adjustment for strata employed. Standard errors clustered around primary sampling unit are reported in parentheses. Average marginal effects reported in square brackets. All regressions include year fixed effects and an intercept. Reference categories are age 17-20 years, high school education, family income \$35,000-39,999, married, and white race. Observations with missing information excluded from the analysis sample.

\*\*\*,\*\*,\*=statistically different from zero at 1%; 5%;10% confidence level.

Table 6B. Correlates of meeting military active duty enlistment standards for weight and body fat, women in Continuous NHANES (1999-2008)

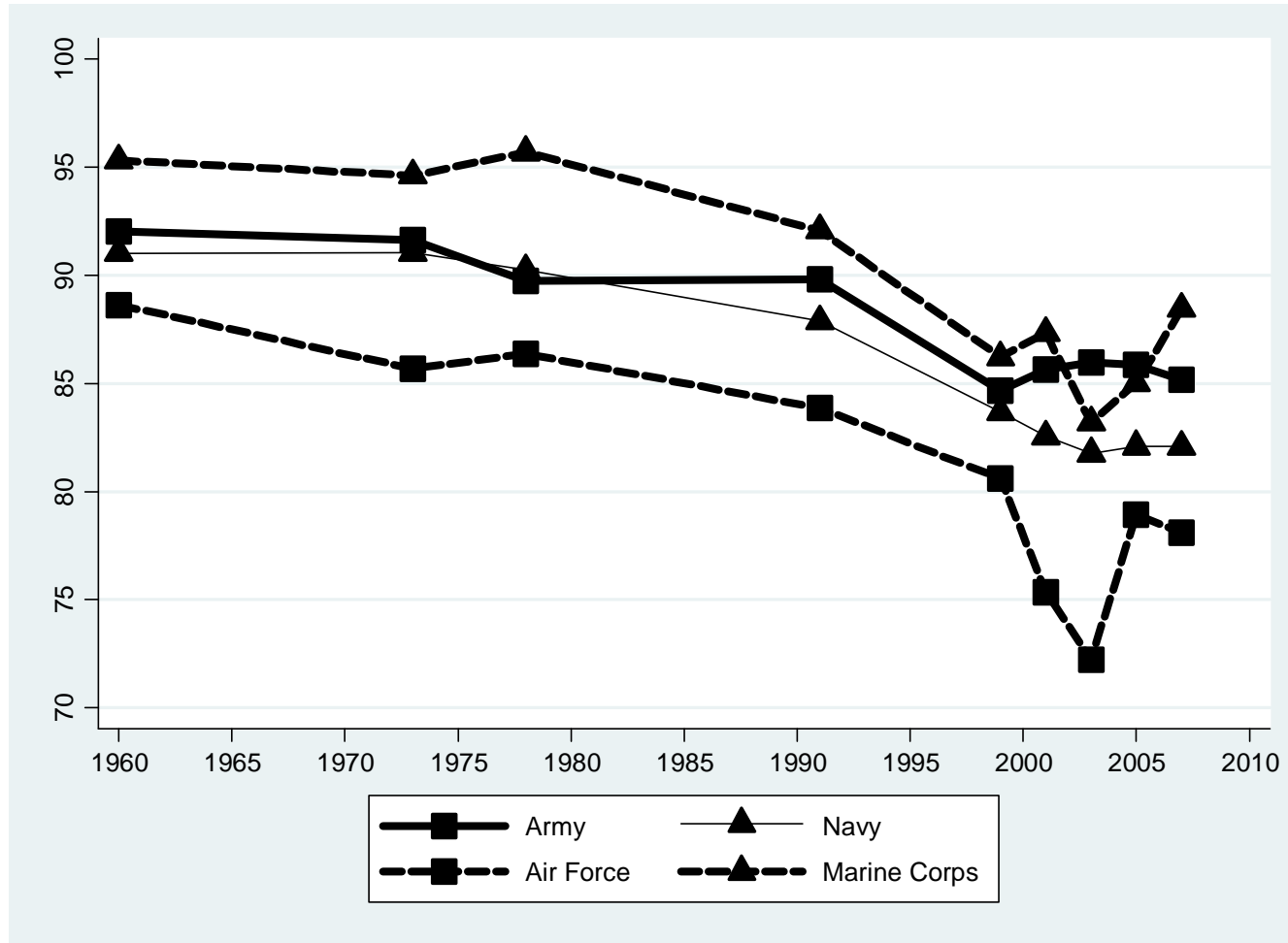
	Army (17-42 yrs)	Navy (17-34 yrs)	Air Force (17-27 yrs)	Marine Corps (17-28 yrs)
<i>Age</i>				
20-24 Years	-0.1628* (0.0848) [-0.0602]	-0.2982*** (0.0980) [-0.0887]	-0.2146** (0.0902) [-0.0738]	-0.1196 (0.0862) [-0.0451]
25-29 Years	-0.3797*** (0.0876) [-0.1404]	-0.6243*** (0.1153) [-0.1858]	-0.3177*** (0.1155) [-0.1093]	-0.2867*** (0.1050) [-0.1081]
30-34 Years	-0.3407*** (0.0898) [-0.1260]	-0.6684*** (0.1080) [-0.1989]	--	--
35-39 Years	-0.2895*** (0.0925) [-0.1071]	--	--	--
40-42 Years	-0.3582*** (0.0871) [-0.1325]	--	--	--
<i>Family Income</i>				
0-4,999	0.1194 (0.1290) [0.0442]	0.0795 (0.1674) [0.0237]	0.0545 (0.1864) [0.0187]	0.0544 (0.1738) [0.0205]
5,000-9,999	0.0399 (0.1139) [0.0148]	-0.0812 (0.1436) [-0.0242]	0.0502 (0.1819) [0.0173]	0.0316 (0.1616) [0.0119]
10,000-14,999	-0.1354 (0.1170) [-0.0501]	-0.1432 (0.1298) [-0.0426]	-0.1452 (0.1909) [-0.0499]	-0.1088 (0.1769) [-0.0410]
15,000-19,999	-0.0725 (0.0965) [-0.0268]	0.0787 (0.1487) [0.0234]	-0.1724 (0.1788) [-0.0593]	-0.1114 (0.1538) [-0.0420]
20,000-24,999	-0.0454 (0.0961) [-0.0168]	-0.0811 (0.1291) [-0.0241]	0.1792 (0.1625) [0.0616]	0.1582 (0.1588) [0.0597]

25,000-34,999	-0.0885 (0.0987) [-0.0327]	-0.0425 (0.1258) [-0.0126]	-0.1630 (0.1561) [-0.0560]	-0.0173 (0.1282) [-0.0065]
45,000-54,999	0.0149 (0.0989) [0.0055]	-0.0738 (0.1365) [-0.0220]	0.0764 (0.1930) [0.0263]	0.0634 (0.1669) [0.0239]
55,000-64,999	0.0799 (0.1157) [0.0295]	-0.0219 (0.1560) [-0.0065]	0.1947 (0.1787) [0.0670]	0.1822 (0.1479) [0.0687]
65,000-74,999	0.0098 (0.1289) [0.0036]	-0.0619 (0.1694) [-0.0184]	0.0877 (0.2332) [0.0302]	-0.0317 (0.1856) [-0.0120]
75,000+	0.1637 (0.1079) [0.0605]	0.2567* (0.1450) [0.0764]	0.1759 (0.1734) [0.0605]	0.2301* (0.1364) [0.0868]
<i>Education</i>				
Less than High School	-0.0413 (0.0625) [-0.0153]	0.0444 (0.0947) [0.0132]	0.0464 (0.0996) [0.0159]	0.0929 (0.0893) [0.0350]
Some College	0.0165 (0.0613) [0.0061]	-0.0211 (0.0827) [-0.0063]	0.2218** (0.0937) [0.0763]	0.1836** (0.0886) [0.0692]
College Graduate	0.3502*** (0.0721) [0.1295]	0.3792*** (0.1011) [0.1129]	0.4711*** (0.1573) [0.1620]	0.3807*** (0.1360) [0.1436]
<i>Marital Status</i>				
Divorced	0.0663 (0.0895) [0.0245]	-0.0995 (0.1261) [-0.0296]	-0.3152 (0.2668) [-0.1084]	-0.0641 (0.2548) [-0.0242]
Never Married	0.0310 (0.0626) [0.0115]	0.0800 (0.0887) [0.0238]	0.0590 (0.0922) [0.0203]	0.1555* (0.0899) [0.0586]
<i>Race/Ethnicity</i>				
Black	-0.3983*** (0.0567) [-0.1473]	-0.5315*** (0.0844) [-0.1582]	-0.4351*** (0.0817) [-0.1496]	-0.4429*** (0.0914) [-0.1670]

Hispanic	-0.0733 (0.0621) [-0.0271]	-0.1453* (0.0838) [-0.0432]	-0.1818** (0.0836) [-0.0625]	-0.1933** (0.0880) [-0.0729]
Other	-0.0048 (0.0966) [-0.0018]	0.1800 (0.1227) [0.0535]	-0.3004** (0.1324) [-0.1033]	-0.1870 (0.1223) [-0.0705]
<i>Unweighted N</i>	4801	3502	2485	2609

*Notes:* See Appendix Tables for current military enlistment weight standards. Historical sampling weights and adjustment for strata employed. Standard errors clustered around primary sampling unit are reported in parentheses. Average marginal effects reported in square brackets. All regressions include year fixed effects and an intercept. Reference categories are age 17-20 years, high school education, family income \$35,000-39,999, married, and white race. Observations with missing information and pregnant women excluded from the analysis sample. \*\*\*,\*\*,\*=statistically different from zero at 1%; 5%;10% confidence level.

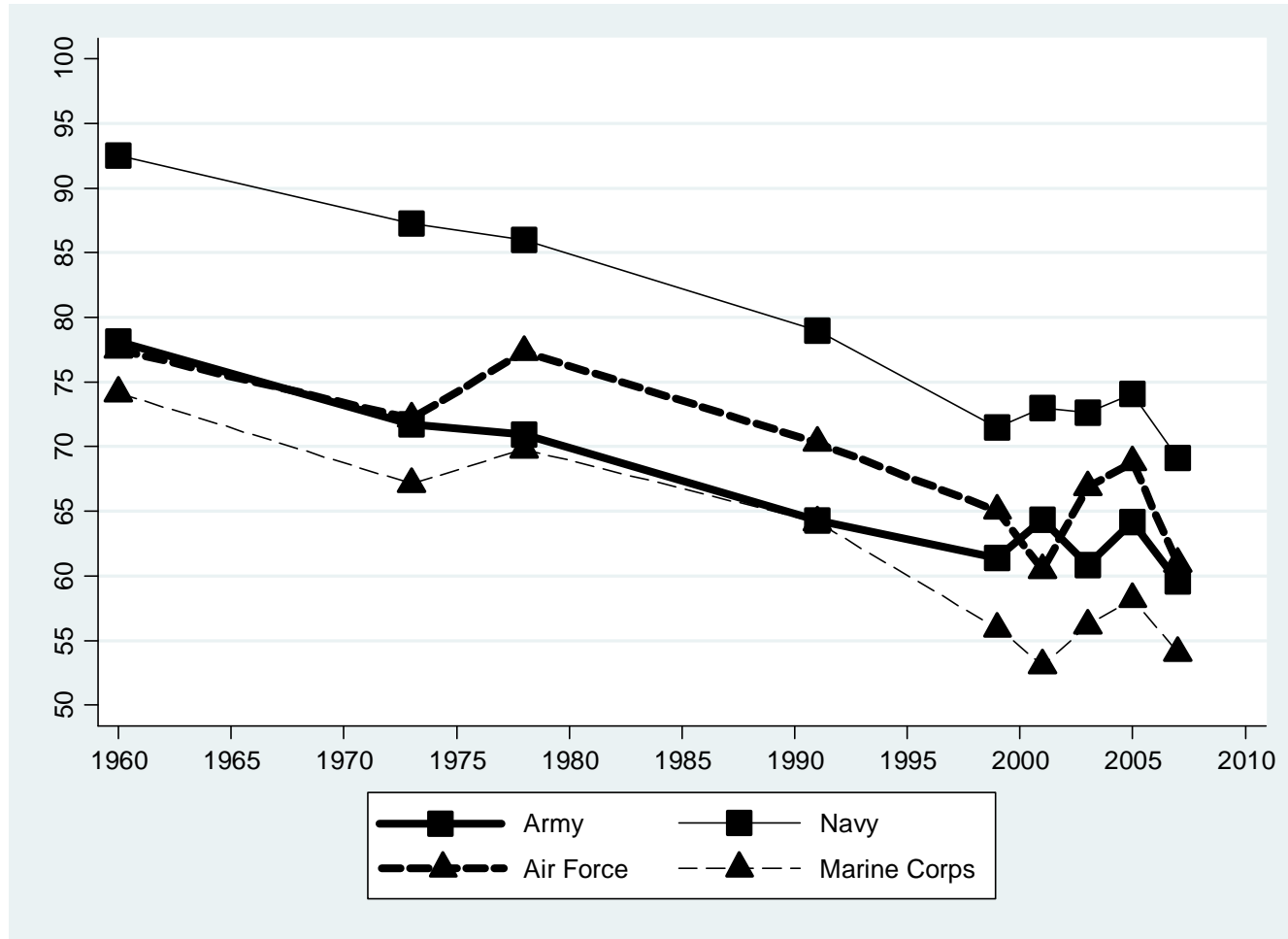
Figure 1. Percent of military-age male civilians who meet military active duty enlistment standards for weight and body fat, by service and survey



Notes: Data: NHES (1959-62), NHANES I (1971-75), NHANES II (1976-80), NHANES III (1988-94), and NHANES Continuous (1999-2000, 2001-02, 2003-04, 2005-06, and 2007-08). See Tables 1A, 2A, 3A, and 4A for survey-specific estimates. For NHES I and NHANES I, II, and III, points are located at the median year of the survey. For NHANES Continuous, points are placed at the first of the two years of the survey.

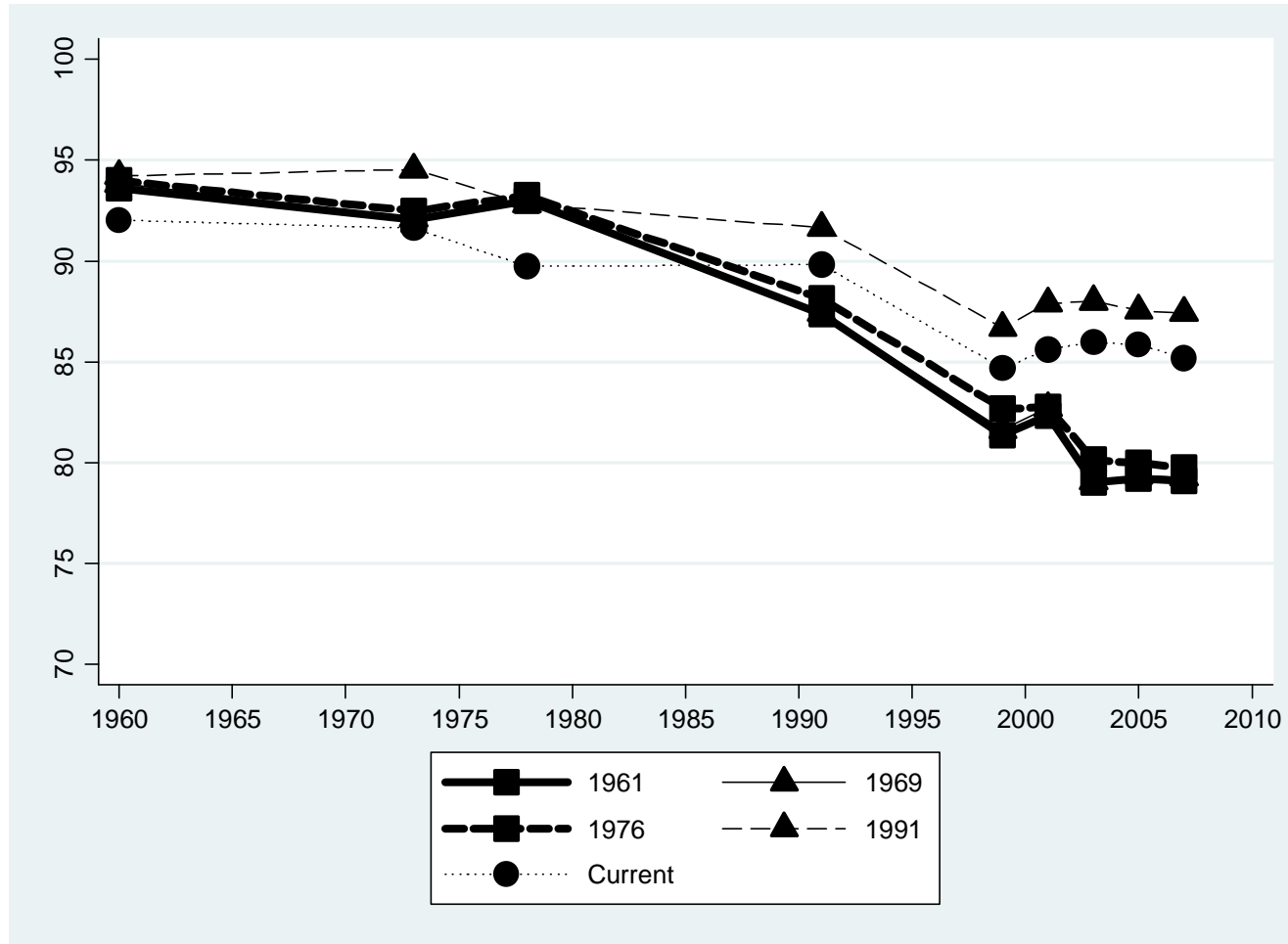


Figure 2. Percent of military-age female civilians who meet military active duty enlistment standards for weight and body fat, by service and survey



Notes: Data: NHES (1959-62), NHANES I (1971-75), NHANES II (1976-80), NHANES III (1988-94), and NHANES Continuous (1999-2000, 2001-02, 2003-04, 2005-06, and 2007-08). See Tables 1B, 2B, 3B, and 4B for survey-specific estimates. For NHES I and NHANES I, II, and III, points are located at the median year of the survey. For NHANES Continuous, points are placed at the first of the two years of the survey.

Figure 3: Percent of military-age male civilians who meet historic Army active duty enlistment standards for weight and body fat, by survey



Notes: Data: NHES (1959-62), NHANES I (1971-75), NHANES II (1976-80), NHANES III (1988-94), and NHANES Continuous (1999-2000, 2001-02, 2003-04, 2005-06, and 2007-08). The current Army standards (used in Figure 1) were issued in 2007. For NHES I and NHANES I, II, and III, points are located at the median year of the survey. For NHANES Continuous, points are placed at the first of the two years of the survey.

Appendix Table A. Current U.S. Army active duty enlistment standards for body weight and percent body fat

	<i>Minimum Weight (lbs)</i>	<i>Maximum Weight (lbs) by Age</i>			
Height (inches)	All	17-20	21-27	28-39	40+
<b>Men</b>					
60	97	139	141	143	146
61	100	144	146	148	151
62	104	148	150	153	156
63	107	153	155	158	161
64	110	158	160	163	166
65	114	163	165	168	171
66	117	168	170	173	177
67	121	174	176	179	182
68	125	179	181	184	187
69	128	184	186	189	193
70	132	189	192	195	199
71	136	194	197	201	204
72	140	200	203	206	210
73	144	205	208	212	216
74	148	211	214	218	222
75	152	217	220	224	228
76	156	223	226	230	234
77	160	229	232	236	240
78	164	235	238	242	247
79	168	241	244	248	253
80	173	247	250	255	259
	All	17-20	21-27	28-39	40+
<b>Women</b>					
58	91	122	124	126	127
59	94	127	128	130	131
60	97	132	134	135	136
61	100	136	137	139	141
62	104	140	141	144	145
63	107	145	147	148	149
64	110	149	151	153	154
65	114	154	156	158	160

66	117	160	160	162	165
67	121	163	166	168	169
68	125	168	171	173	174
69	128	173	176	178	180
70	132	178	181	183	185
71	136	183	186	188	191
72	140	189	191	194	196
73	144	194	196	200	202
74	148	199	203	204	206
75	152	205	208	210	212
76	156	210	213	215	216
77	160	216	219	221	223
78	164	222	224	227	229
79	168	227	230	234	236
80	173	233	236	240	241
<i>Maximum % Body Fat</i>					
Men	--	26	26	28	30
Women	--	32	32	34	36

Notes: Source is Army Regulation 40-501 Table 2-1 and Table 2-2 (December, 2007). Eligible age range is 17-42 years.

Appendix Table B. Current U.S. Navy enlistment standards for body weight and percent body fat

<i>Maximum Weight (lbs)</i>		
Height (inches)	Men	Women
51	97	102
52	102	106
53	107	110
54	112	114
55	117	118
56	122	123
57	127	127
58	131	131
59	136	136
60	141	141
61	145	145
62	150	149
63	155	152
64	160	156
65	165	160
66	170	163
67	175	167
68	181	170
69	186	174
70	191	177
71	196	181
72	201	185
73	206	189
74	211	194
75	216	200
76	221	205
77	226	211
78	231	216
79	236	222
80	241	227
81	246	233
82	251	239
83	256	245

84	261	251
85	266	257
86	271	263
<i>Maximum % Body Fat</i>		
17-39 years	22	33
40+ years	23	34

*Notes:* Source is OPNAVINST 6110.1H (August 15, 2005; Appendix A). Eligible age range is 17-34 years.

Appendix Table C. Current U.S. Air Force enlistment standards for body weight and percent body fat

<i>Weight Requirements</i>		
Height (inches)	Minimum Weight (lbs)	Maximum Weight (lbs)
58	91	131
59	94	135
60	97	141
61	100	145
62	104	150
63	107	155
64	110	160
65	114	165
66	117	170
67	121	175
68	125	180
69	128	186
70	132	191
71	136	197
72	140	202
73	144	208
74	148	214
75	152	220
76	156	225
77	160	231
78	164	237
79	168	244
80	173	250
Maximum % Body Fat		
	Men	Women
<30 years	20%	28%
>=30 years	24%	32%

Notes: Source Air Force Instruction 48-123 V2 (June 5, 2006). Eligible age range is 17-27years.

Appendix Table D. Current U.S. Marine Corps enlistment standards for body weight and percent body fat

	<i>Minimum Weight (lbs)</i>	<i>Maximum Weight (lbs) by Age</i>		
<i>Men</i>				
Years	All	17-20	21-30	31-35
Height (inches)				
58	96	148	153	152
59	98	153	158	157
60	100	158	163	162
61	102	163	168	167
62	103	168	174	173
63	104	174	180	178
64	105	179	185	184
65	106	185	191	190
66	107	191	197	196
67	111	197	203	202
68	115	203	209	208
69	119	209	215	214
70	123	215	222	220
71	127	221	228	227
72	131	227	234	233
73	135	233	241	240
74	139	240	248	246
75	143	246	254	253
76	147	253	261	260
77	151	260	268	266
78	153	267	275	273
79	157	274	282	277
80	160	281	288	285
<i>Women</i>				
Years	All	17-20	21-27	28-39
Height (inches)				
58	91	120	123	126
59	94	124	127	130
60	97	128	131	134
61	100	132	135	138



62	104	137	140	143
63	107	141	144	147
64	110	146	149	152
65	114	150	153	156
66	117	155	157	161
67	121	160	163	166
68	125	164	167	170
69	128	169	173	175
70	132	174	177	180
71	136	179	181	185
72	140	184	187	190
73	144	189	192	195
74	148	195	197	201
75	152	200	203	206
76	156	205	208	211
77	160	211	214	217
78	164	216	219	222
79	168	222	225	228
80	173	228	231	234
<i>Maximum % Body Fat</i>				
Men	--	18	18	18
Women	--	26	26	26

*Notes:* Source is Marine Corps Order P1100.72C Table 3-8 and Table 3-9 (June, 2004). Eligible age range is 17-28 years.