7-23-2021

Relationship Between Body Mass Index and Diagnosis of Obesity in the Military Health System Active Duty Population

Daren Yang
Brooke Army Medical Center

Alexis Beauvais
Eisenhower Army Medical Center

Whitney L. Forbes
Defense Health Agency

Darrick Beckman
Wilford Hall Ambulatory Surgical Center

Jason Estes
Brooke Army Medical Center

See next page for additional authors

Authors
Daren Yang, Alexis Beauvais, Whitney L. Forbes, Darrick Beckman, Jason Estes, Craig Martinez, and Jana L. Wardian PhD

MILITARY MEDICINE, 00, 0/0:1, 2021

Relationship Between Body Mass Index and Diagnosis of Obesity in the Military Health System Active Duty Population

MAJ Daren Yang, DO, USA; MAJ Alexis Beauvais, MD, USAF†; Whitney L. Forbes, PhD‡,§; MAJ Darrick Beckman, MD, USAF§; CPT Jason Estes, DO, USA*; Craig Martinez§; Jana Wardian, PhD§*

ABSTRACT

Objective:

The overall rate of obesity is rising in the USA; this is also reflected in the military population. It is important that providers appropriately diagnose obesity and discuss treatment options with their patients.

The purpose of this study was to investigate diagnosis of obesity compared to documented body mass index (BMI) in the military health system.

Methods:

Institutional review board approval was obtained by the 59th Medical Wing (Lackland Air Force Base, Texas) as an exempt study. This study included active duty military service members aged 18-65 years who sought outpatient care at a military treatment facility from September 2013 to August 2018 with a weight within the range of 31.8-226.8 kg and height between 121.9 and 215.9 cm. Data were collected from the Clinical Data Repository vitals and M2 encounter data to determine the percentage of each sub-population with a diagnosis of obesity according to BMI ($\geq$30 kg/m^2) and International Classification of Diseases diagnosis codes.

Results:

Using BMI, 19.2% of female and 26.8% of male service members can be diagnosed with obesity; however, only 42.2% and 35.1%, respectively, with a BMI $\geq$30 was diagnosed as such. This discrepancy was consistent among all service branches and BMI ranges.

Conclusion:

This study demonstrates that obesity is underdiagnosed compared to BMI. This may result in insufficient resources being provided to patients to reduce weight. Further investigation is warranted to identify causes of underdiagnosis and potential barriers to diagnosis.

INTRODUCTION

It is well known that the overall obesity rate for adults in the USA continues to rise; while not as well known, obesity rates also continue to rise in the U.S. military population.[1–3] This has increased military service members' risk of developing many health conditions associated with obesity including cardiovascular disease, insulin resistance, and metabolic syndrome.[4] Furthermore, military readiness is negatively impacted by the rising rate of obesity, which is associated with increased injury risk and decreased physical performance.[5,6]

As per the American College of Cardiology and American Heart Association Obesity Expert Panel is calculated as an individual's weight in kilograms divided by the square of height in meters. Obesity is defined as a BMI $\geq$30 kg/m2.[7] In a more physically active population, such as the military, BMI may become less accurate as an indicator for physical fitness, as this population may have a higher muscle mass and, thus, a weaker correlation between BMI and percentage fat.[8,9] However, with BMI values $\geq$30, the correlation with obesity is generally strong.[10,11] The accurate identification and diagnosis of obesity is the first step before the evaluation and treatment for obesity and associated comorbidities.

One of the challenges facing service members is that they may have a misperception of their weight status given the unique demands of the military.[12] At a minimum, active duty service members are required to meet height and weight standards. Depending on the branch of service, service members may be required to maintain a BMI below a specific limit; exceeding this limit may require additional testing to assess

*Department of Medicine, Brooke Army Medical Center, Fort Sam Houston, TX 78234, USA

†Department of Endocrinology, Eisenhower Army Medical Center, Fort Gordon, GA 30905, USA

‡Data Innovation, Enterprise Intelligence and Data Solutions PMO, Defense Health Agency, Falls Church, VA 22042, USA

§Diabetes Center of Excellence, Wilford Hall Ambulatory Surgical Center, Lackland AFB, TX 78236, USA

Data were previously presented at the 2019 Military Health System Research Symposium Conference at Orlando, FL, on August 20, 2019.

The view(s) expressed herein are those of the author(s) and do not reflect the official policy or position of Brooke Army Medical Center, Wilford Hall Ambulatory Surgical Center, Eisenhower Army Medical Center, Defense Health Agency, the U.S. Army Medical Department, the U.S. Army Office of the Surgeon General, the Department of the Army, the Department of the Air Force, the Department of Defense, or the U.S. Government.

doi:https://doi.org/10.1093/milmed/usab292

body fat percentage via waist and neck circumference measurements. Males can range from 20% to 26% body fat and females can range from 30% to 36% body fat depending on age category. Technically, a 41-year-old female with BMI of 31 can pass the physical fitness test if body fat is calculated to be 36%.[13] This discrepancy, which is created by the military in allowing its own physical height and weight parameters that do not align with the universal medical standard for obesity, may ultimately lead to individual dissonance and inability to accept their true weight category.[12] This is problematic because the positive reinforcement given for meeting military-specific weight goals might prevent important attempts at diet and lifestyle modifications in order to achieve an appropriate BMI.

Service members have also been shown to have increased motivation to lose weight when diagnosed as overweight or with obesity.[14] Motivations similar to civilian counterparts include improved quality of life, physical health, and life expectancy. Unique motivators to service members include passing the physical fitness test and meeting required height/weight standards. Motivation to want to lose weight was also shown to be greater in higher ranking and higher educational status service members.[15] This was thought to be tied to a greater concern about passing fitness tests and meeting the appropriate height/weight standards. Failing fitness tests or height/weight standards could result in loss of career, health insurance, and possibly their pension.

In a survey of people with obesity ($n = 3{,}008$) and healthcare providers (HCPs) ($n = 606$), attitudes toward and perceptions of obesity varied.[16] Although obesity is perceived as a disease by the majority of people with obesity (65%) and HCP (80%), providers and patients struggle with talking about weight for different reasons.[16] Patients who do not seek help from their HCP believe it is their personal responsibility (44%); they already know what to do (37%); and/or do not have financial means to support a weight loss effort (23%). The primary reasons HCP did not initiate discussions about weight loss were time constraints (52%) and having more important issues to discuss with the patient (45%). Other HCP beliefs cited were that the patient was not motivated to lose weight (27%); the patient was not interested in weight loss (26%); and/or concern over emotional state or psychological issues (22%).[16] For patients that had weight loss discussions with their HCP, 47% of patients reported broaching the topic while 53% reported the HCP mentioning weight loss. This was very different according to HCP who report that they brought up weight loss (67%) versus the patient (33%).[16]

Recognition and coding for obesity in civilian healthcare settings is poor. One study found that while 52% patients met objective criteria for obesity (BMI ≥30), only 5.6% of patient records included an obesity code; another study found that 40% of patients that met the definition of obesity of BMI ≥30 were not coded as such.[17,18] A cross-sectional study using 2005-2006 National Ambulatory Medical Care Survey data revealed that nearly 50% of clinical visits did not have complete height and weight records to facilitate calculating BMI. In addition, of patient encounters with a BMI ≥30, 66-74% lacked obesity coding in the health record.[19] A smaller study ($n = 289$) in Israel examined data from seven family practice clinics and found that 27% of patients could be diagnosed with obesity (BMI ≥30) and only 24% of those were documented as such.[20] It is even more alarming that 66% of patients with known obesity comorbidities (including type 2 diabetes, hypertension, obstructive sleep apnea, etc.) were not diagnosed with obesity.[16] A Mayo Clinic primary care study ($n = 9{,}827$) examined data from 2004 to 2005 and found that 25.9% of patients can be diagnosed with obesity by BMI with the majority lacking obesity documentation (80.1%).[21] Furthermore, older patients and men were significantly less likely to have an obesity diagnosis, and the presence of an obesity diagnosis was the strongest predictor of creating a plan to address obesity.[21]

The purpose of this study was to first determine an accurate rate of obesity in active duty service members who sought clinical care in the military health system. Then, we investigated the rates of diagnosis coding of obesity among individuals with a BMI fitting an obesity diagnosis and how these rates compare based on age and gender.

METHODS

Data were collected from the Defense Health Agency Clinical Data Repository vitals and Military Health System Management Analysis and Reporting Tool (M2) encounter data from September 1, 2013 to August 31, 2018. Only active duty service members with a clinical encounter at a military treatment facility (MTF) with vitals during this period were included (Fig. 1).

Records were included if they met the following inclusion criteria: (1) DOD identification number present; (2) between 18 and 65 years old; (3) 31.8-226.8 kg; and (4) 121.9-215.9 cm tall. All included records met the National Heart, Lung, and Blood Institute guidelines for obesity defined as a BMI ≥30.[7] The BMI was calculated based on height and weight as BMI = weight in kilograms/(height in meters).[2]

Exclusion criteria were the following: (1) questionable accuracy of sponsor service branch; (2) missing or undetermined gender; (3) height inaccuracies defined as multiple heights not within 5 inches; and (4) pregnant women during the study period. Finally, obesity International Classification of Diseases (ICD) codes for the clinical encounter were added. Obesity ICD-10 codes included E66.0, E66.01, E66.09, E66.8, and E66.9. Obesity ICD-9 codes 278.00 and 278.01 were also included. Overweight ICD codes were not included.

The age groups used for analysis were taken directly from the Clinical Data Repository vitals data. The groups for 45 years old or older were collapsed into one group representing 45-65 years old to protect the identities of those analyzed.

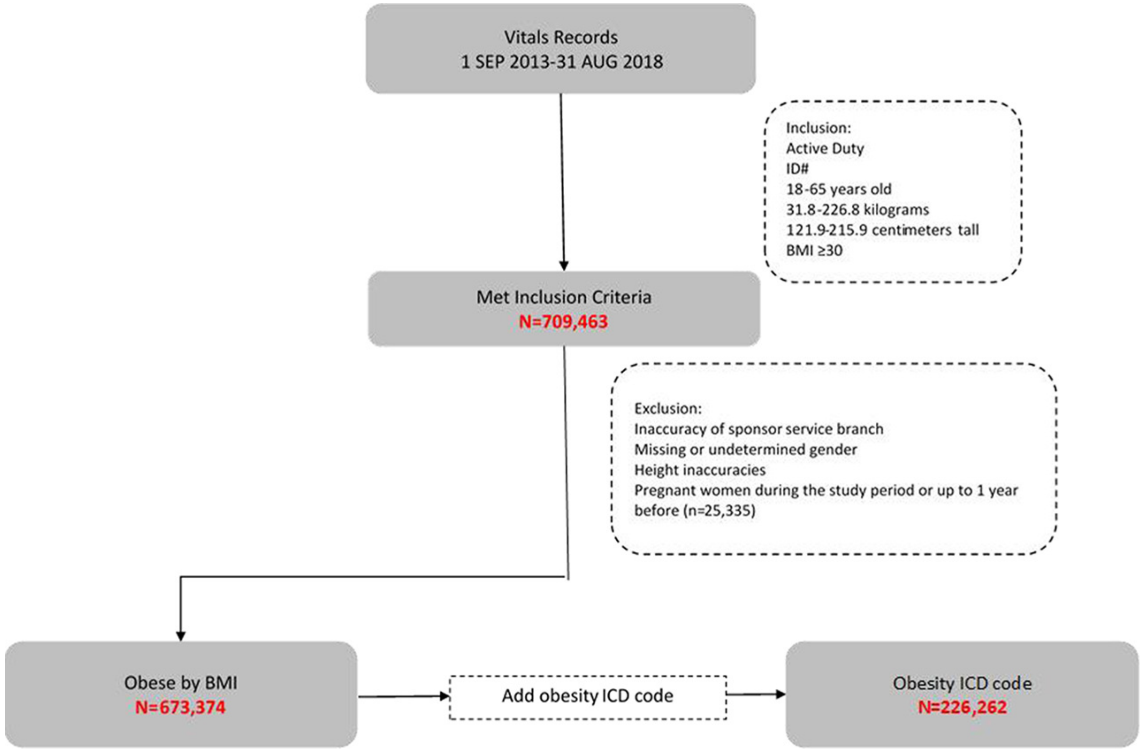


FIGURE 1. Methodology for extracting obesity data.

Statistical association between the rate of coding and the different categorical variables was tested using Pearson's chi-square test. The Mantel–Haenszel chi-square test was used to test for association between coding rates by gender stratified by age group. A significance level of $\alpha = 0.05$ was used for all tests.

RESULTS

Branch of Service (Fig. 2)

By these data, we see similar overall rates of obesity in active duty members by height and weight measurement across the Army, Air Force, and Navy (27.3-30.0%), followed by the Coast Guard (24.2%), and finally by the Marines (15.3%). Coding for obesity differs slightly compared to measured obesity, with the Army and Air Force having similar rates (37.4% and 39.4% respectively), followed by the Navy and Coast Guard (26.7% and 27.0% respectively), and the Marines at 14.8%.

Gender and Age Group (Fig. 3)

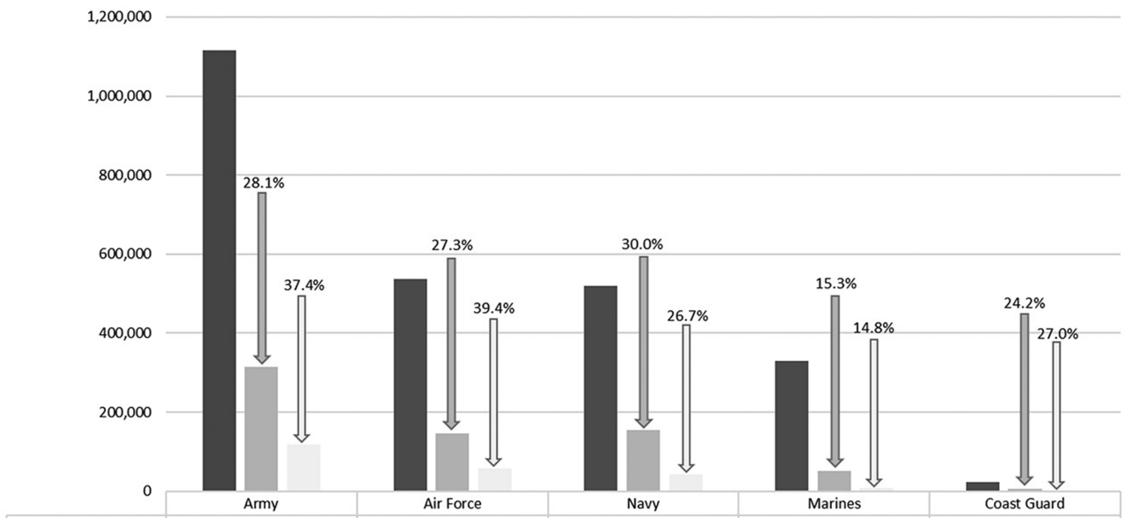
The rate of ICD coding for obesity in the electronic medical record was significantly lower than the rate of active duty service members with BMI meeting obesity criteria. Of 544,478 active duty females, 104,407 (19.2%) met criteria for obesity based on vital sign measurement; however, only 44,082 (42.2%) were coded with an obesity diagnosis at any time. Of those 44,082 females with an obesity diagnosis entered in the electronic medical record, the majority of diagnoses (42,747) were entered within 1 year of a BMI measurement ≥30. A significantly different rate of obesity coding was seen in active duty males with a measured BMI ≥30 ($P < .001$). Of 2,476,968 males, 664,814 (26.8%) had a BMI ≥30 recorded vital sign record. Of males meeting criteria for obesity, 233,425 (35.1%) had coding for an obesity diagnosis; the majority of these (232,385) were coded within 1 year of the BMI ≥30 vital sign measurement.

There was a significant association between age group and being diagnosed as obese ($P < .001$). Service members were less likely to receive a coded obesity diagnosis if they were 24 years of age or younger (33.8% of females and 29.1% of males aged 18-24 years). Individuals in the 35-44 and 45-65 year old age groups were more likely to be coded for obesity when meeting diagnostic criteria.

Controlling for age group, females meeting diagnostic criteria for obesity were more likely to be coded with an obesity diagnosis ($P < .001$). Furthermore, 49.4% of females fitting a diagnosis of obesity by BMI aged 35-44 years and 47.3% of females aged 45-65 years were coded with a diagnosis of obesity. In addition, 48.0% of males fitting a diagnosis of obesity by BMI aged 35-44 years and 38.8% of males aged 45-65 years were coded with a diagnosis of obesity.

BMI Range Differences (Fig. 4)

The rate of coding for obesity in active duty service members differed significantly between the BMI ranges with the rate of coding decreasing as BMI ranges increased ($P < .001$).



	Army	Air Force	Navy	Marines	Coast Guard
Population from Electronic Vitals Records	1,116,309	537,168	518,802	330,118	22,705
Obese by BMI	314,684	146,894	155,644	50,648	5,504
Coded for Obesity	117,679	57,972	41,604	7,519	1,488

FIGURE 2. Body mass index (BMI) and obesity coding by branch of service in active duty individuals.

Of 633,768 individuals with a BMI of 30-34, 34.5% (218,353) were coded for obesity. Of 34,424 individuals with a BMI of 35-39, 20.7% (7118) were coded for obesity. Lastly, of 4,615 service members with a BMI ≥40, only 12.3% (566) were coded for obesity at any time. It should be noted that the sample size for service members with BMI ≥35 was smaller than that of service members with a BMI 30-34.

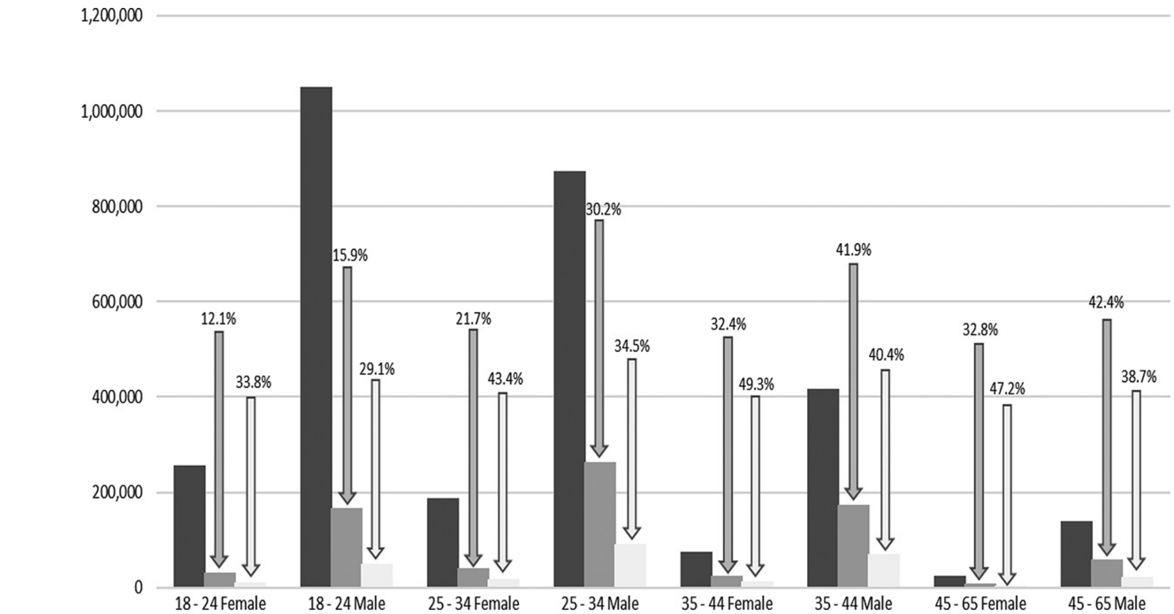
DISCUSSION

This study confirmed that obesity is a common health concern for the active duty military population, for both genders and across all age groups. This study also revealed that the rate of diagnosis with clinical obesity in the EMR for active duty service members meeting criteria is considerably lower than the actual rate of obesity in this population. More than half of active duty females and about two-thirds of active duty males with a BMI meeting criteria for obesity did not receive an ICD-coded diagnosis in the EMR. This represents a gap between the prevalence of obesity in service members and clinical documentation of this condition.

Gender disparities in coding may be explained by weight-related beliefs and behaviors. A prior study showed that women tend to be more concerned about their weight and more likely to broach the topic at a clinical visit, which prompts the HCP to discuss it.[16] Conversely, men may be more likely to believe that weight management is their personal responsibility or they already know what to do to address weight management.[16] There may also be the perception that men are heavier due to muscle mass; although with a BMI ≥30, the correlation with obesity is generally strong.[10,11]

The youngest age group of service members are the least likely to be coded with obesity when this condition exists. Obesity should be identified and addressed early to prevent morbidity and mortality from associated medical conditions. This is concerning when considering operational readiness, duty performance, deployment capability, and retention. Older patients in our study were more likely to receive an ICD-coded diagnosis, but identification of overweight and obesity in younger service members would allow for early intervention and prevention of conditions related to obesity. The disparity in coding of obesity in individuals with a BMI ≥30 between services could be influenced by several factors. Medical providers may have received different coding training in different services and in different MTFs. Some MTFs include ICD diagnosis of abnormal vital signs (coding for elevated blood pressure, BMI ≥30, and tachycardia for elevated heart rate) in quality assessment metrics, which may lead to a higher rate of diagnosis. There may be a perception in some services that diagnosis of obesity in the medical record has a negative connotation that can impact the service member's career. The body composition of the average service member from different services may vary. In future research, comparing fitness testing data which include waist measurement with BMI would be helpful to more fully evaluate BMI measurement.

There was a relatively similar rate of measured obesity between four of five services with the Army, Air Force, Navy,



	18 - 24 Female	18 - 24 Male	25 - 34 Female	25 - 34 Male	35 - 44 Female	35 - 44 Male	45 - 65 Female	45 - 65 Male
Population from Electronic Vitals Records	257,060	1,049,674	188,114	872,853	75,146	415,956	24,158	138,485
Obese by BMI	31,165	167,560	40,911	263,950	24,385	174,482	7,946	58,822
Coded for Obesity	10,528	48,784	17,755	91,189	12,042	70,634	3,757	22,818

FIGURE 3. Body mass index (BMI) and obesity coding by age and gender in active duty individuals.

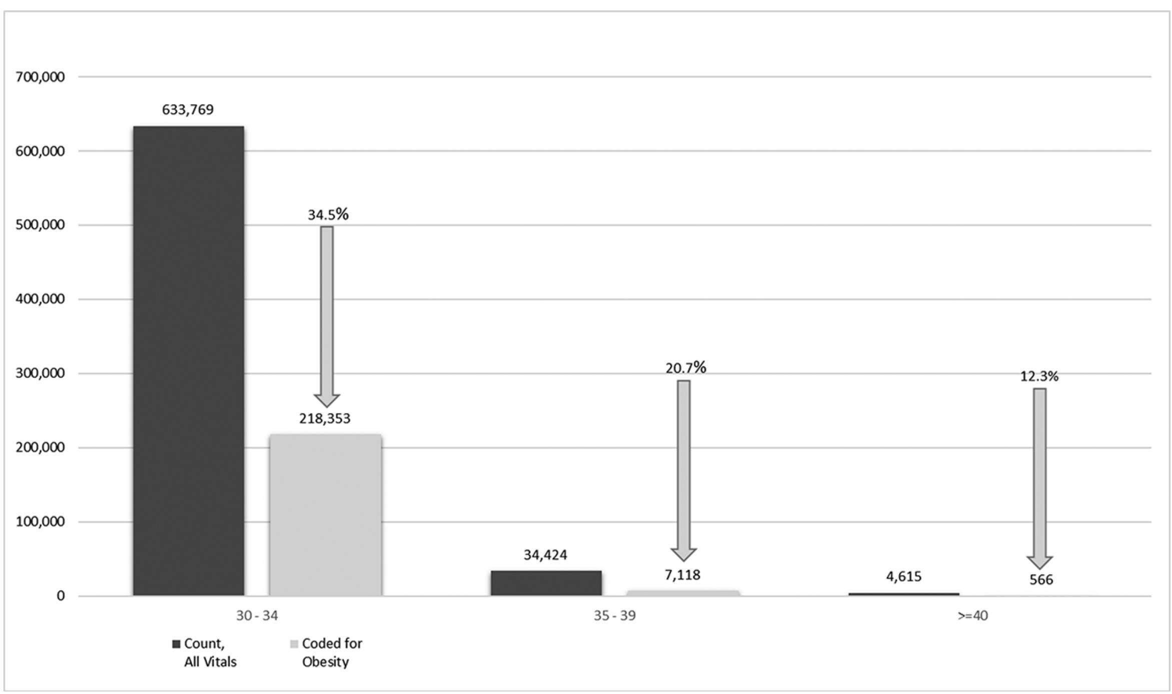


FIGURE 4. Body mass index (BMI) ranges and obesity coding in active duty individuals.

and Coast Guard ranging between 27% and 30% while the Marines with only 15.3%. This lends some credence to the general thought that Marines are more physically active and fit. Interestingly, the Marines have the lowest rate of coding for obesity at 14.8% while the Army and Air Force have the highest rate (37.4% and 39.4%, respectively) and the Navy and Coast Guard fall in between (26.7% and 27.0%, respectively). Without further information, we cannot assess why this coding discrepancy exists; it certainly could be impacted by the training of providers in different services, different MTF practices, or concern for career impact. Another possible reason, in particular for the Marines "poor" coding, is that indeed a higher portion of these patients are truly physically fit with a low body fat percentage but meet BMI obesity criteria based on height and weight and are therefore not coded for obesity.

Obesity was also less likely to be diagnosed among service members with higher BMIs, particularly in individuals with morbid obesity. Possibilities as to why this is occurring include provider bias with higher BMI individuals and other health issues that could predispose one to a higher BMI. It is also possible that these service members could be separated from the military much earlier than lower BMI service members and lack adequate follow-up for diagnosis and treatment. Further investigation would need to be done to explore this phenomenon.

It is important to note, however, that a higher rate of coded obesity diagnosis does not necessarily mean that a patient was counseled regarding obesity, nor that the patient received obesity-specific treatment; this could be explored in future research. We also did not analyze whether receiving an obesity diagnosis had an impact on an individual's BMI trajectory compared to individuals who did not receive a diagnosis of obesity. Although recognition of obesity is the necessary first step in treatment, this condition is multifaceted and can be challenging for patients and HCPs to manage.

A limitation of this study was the use of BMI to calculate obesity prevalence. Gold standard for diagnosis of obesity is body fat composition but this is not practical for a retrospective study in this population due to available information and cost. Because of this limitation, we chose to exclude the overweight BMI, which could lead to overestimation in active duty members with increased amounts of lean body mass. As we expand this study, we hope to obtain waist circumference data which are recorded at least annually for active duty members associated with fitness testing for more data points. Another aspect of this study that influences interpretation is the exclusion of females with a pregnancy diagnosis from statistical analysis. This represented 25,335 individuals, which may have affected the female obesity rates had they been included. The rate of obesity before pregnancy, following pregnancy, and with single versus multiple pregnancies is an area which should be examined in future research; this may help to identify a subgroup of the active duty population that could benefit from a targeted weight management early intervention.

Service members carrying diagnoses that could lead to an elevated BMI not caused by percentage fat such as congestive heart failure, hepatic or renal disease, or malignancies were not accounted for in the data analysis. However, we expect this number to be small due to the physical requirements of the military, as most of these individuals will be medically separated, and would not have a significant impact on the overall data.

CONCLUSION

Although common perception is that the military is a population that is less susceptible to obesity, our data have shown that service members receiving care in MTFs have a high obesity rate and are not consistently coded as such, at least among those seeking care. Underdiagnosis and undertreatment of obesity can have major implications in the overall military readiness and the general health of the military health system population.[4,5] We found a major discrepancy between obesity as measured by BMI (about 25% of active duty status across all services) and actually being diagnosed with the ICD code (12.5% of those who fit the diagnosis for obesity by BMI). Furthermore, this is occurring despite increased access to health care for active duty members compared to the civilian population due to the availability of universal healthcare coverage for active duty service members through the TRICARE program. It is clear that the active duty population is just as affected as the civilian population in regard to obesity diagnoses, and further studies should investigate why this is occurring and potential barriers to care. If active duty members do not receive the ICD code diagnosis, they are likely not receiving necessary information and referral for weight reduction which includes nutrition, exercise programs, and obesity education. This could lead to downstream effects that can have a major burden on healthcare costs, but also represents a direct threat to our mission of military readiness.

ACKNOWLEDGMENTS

W.L.F. and C.M. collected and analyzed data. All authors were involved in writing the paper and gave final approval of the submitted and published versions. There are no further acknowledgments.

FUNDING

This study was supported by the Chief Scientist, Science and Technology Office.

CONFLICT OF INTEREST STATEMENT

The authors declared no conflict of interest.

REFERENCES

1. Smith TJ, Marriott BP, Dotson L et al: Overweight and obesity in military personnel: sociodemographic predictors. Obesity 2012; 20(7): 1534–8.

2. Clark LL, Taubman SB: Update: diagnoses of overweight and obesity, active component, U.S. Armed Forces, 2011-2015. MSMR 2016; 23(9): 9–13.
3. Reyes-Guzman CM, Bray RM, Forman-Hoffman VL, Williams J: Overweight and obesity trends among active duty military personnel: a 13-year perspective. Am J Prev Med 2015; 48(2): 145–53.
4. Hruby A, Bulathsinhala L, McKinnon CJ et al: Body mass index at accession and incident cardiometabolic risk factors in US Army soldiers, 2001–2011. PLoS One 2017; 12(1): 1–15.
5. Rappole C, Grier T, Anderson MK, Hauschild V, Jones BH: Associations of age, aerobic fitness, and body mass index with injury in an operational Army brigade. J Sci Med Sport 2017; 20(Suppl 4): S45–50.
6. Teyhen DS, Rhon DI, Butler RJ et al: Association of physical inactivity, weight, smoking, and prior injury on physical performance in a military setting. J Athl Train 2016; 51(11): 866–75.
7. American College of Cardiology/American Heart Association Task Force on Practice Guidelines, Obesity Expert Panel, 2013: Expert Panel Report: Guidelines (2013) for the management of overweight and obesity in adults. Obesity (Silver Spring) 2014; 22(Suppl 2): S41–410.
8. Ode JJ, Pivarnik JM, Reeves MJ, Knous JL: Body mass index as a predictor of percent fat in college athletes and nonathletes. Med Sci Sports Exerc 2007; 39(3): 403–9.
9. Witt KA, Bush EA: College athletes with an elevated body mass index often have a high upper arm muscle area, but not elevated triceps and subscapular skinfolds. J Am Diet Assoc 2005; 105(4): 599–602.
10. Grier T, Canham-Chervak M, Sharp M, Jones BH: Does body mass index misclassify physically active young men. Prev Med Rep 2015; 2: 483–7.
11. Porto LG, Nogueira RM, Nogueira EC et al: Agreement between BMI and body fat obesity definitions in a physically active population. Arch Endocrinol Metab 2016; 60(6): 515–25.
12. Clark HL, Heileson J, DeMay J, Cole RE: Misperceptions of weight status in military men and women. Mil Med 2017; 182(5): e1792–8.
13. DoD Instructions 1308.3. *DoD Physical Fitness and Body Fat Programs Procedures*. Department of Defense; 2002.
14. Maclin-Akinyemi C, Krukowski RA, Kocak M, Talcott GW, Beauvais A, Klesges RC: Motivations for weight loss among active duty military personnel. Mil Med 2017; 182(9): e1816–23.
15. Fahey MC, Hare ME, Talcott GW et al: Characteristics associated with participation in a behavioral weight loss randomized control trial in the U.S. military. Mil Med 2019; 184(3–4): e120–6.
16. Kaplan LM, Golden A, Jinnett K et al: Perceptions of barriers to effective obesity care: results from the national ACTION study. Obesity 2018; 26(1): 61–9.
17. Mattar A, Carlston D, Sariol G et al: The prevalence of obesity documentation in primary care electronic medical records. Appl Clin Inform 2017; 26(1): 67–79.
18. Kapoor A, Kim J, Zeng X, Harris ST, Anderson A: Weighing the odds: assessing underdiagnosis of adult obesity via electronic medical record problem list omissions. Digital Health. 2020; 6.
19. Ma J, Xiao L, Stafford RS: Adult obesity and office-based quality of care in the United States. Obesity 2009; 17(5): 1077–85.
20. Melamed OC, Nakar S, Vinker S: Suboptimal identification of obesity by family physicians. Am J Manag Care 2009; 15(9): 619–24.
21. Bardia A, Holtan SG, Slezak JM, Thompson WG: Diagnosis of obesity by primary care physicians and impact on obesity management. Mayo Clin Proc 2007; 82(8): 927–32.