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ABSTRACT

Introduction:

The prevalence of prediabetes is estimated to be one-third of Americans with approximately 80% of these individuals unaware of the diagnosis. In the active duty military population, the prevalence of prediabetes is largely unexplored. The purpose of this study was to investigate the prevalence of prediabetes in military service members by quantifying those meeting prediabetes screening criteria, those actually being screened, and those being appropriately diagnosed.

Materials and Methods:

Data were analyzed from calendar years 2014 to 2018 for active duty service members 18 years of age or older. Vitals records were collected to obtain body mass index values. Composite Health Care System laboratory data were queried for hemoglobin A1c (HbA1c) results as well as fasting plasma glucose (FPG) and oral glucose tolerance test (OGTT) results. The percentage of active duty service members meeting criteria for prediabetes screening was determined by totaling members age 45 and older with members age 18- to 44-year old with a body mass index $\geq$25.0 kg/m^2, then dividing by the total number of members for each respective military branch. The percentage of active duty service members actually screened for prediabetes was determined based on members meeting prediabetes screening criteria who in fact had FPG, OGTT, or HbA1c labs. The total number of labs meeting prediabetes criteria was determined based on those aforementioned labs with results in the prediabetes range (FPG between 100 and 125 mg/dL, OGTT between 140 and 199 mg/dL, or HbA1c range of 5.7%-6.4%). The total number of service members with appropriate prediabetes International Classification of Disease (ICD) code was determined by identifying members with ICD-9 and ICD-10 codes 790.21, 790.22, and R73.01-R73.03 in their medical record.

Results:

From 2014 to 2018, 53.9% of 332,502, 56% of 543,081, and 47.3% of 531,313 active duty service members in the Air Force, Army and Navy, respectively, met criteria for prediabetes screening. The rates of actually screening for prediabetes were similar across the Air Force (4.8%), Army (6.7%), and Navy (5.5%). The percentage with labs meeting prediabetes criteria ranged from 17.9% to 28.4% in the Air Force, 24.2% to 30.3% in the Army, and 24.2% to 30.9% in the Navy. The rate of ICD coding for prediabetes increased from 2014 to 2018 across all branches (29.8%-65.3% for the Air Force, 24.6%-46.8% for the Army, and 40.0%-45.5% for the Navy).

Conclusion:

Screening for prediabetes in the active duty military population is grossly inadequate, and even of those screened, diagnosing those meeting prediabetes criteria is similarly inadequate. Although this scenario is not unique to the Military Health System, but reflective of a larger national problem, efforts should be made within the Military Health System to increase the screening for this common disorder. Identifying service members with prediabetes enables opportunities for targeted interventions to delay or prevent the progression to diabetes mellitus.

INTRODUCTION

The Centers for Disease Control and Prevention (CDC) estimates that approximately 88 million Americans have prediabetes and are at increased risk for developing type 2 diabetes mellitus[1] and cardiovascular disease (CVD).[2–5] The prevalence of prediabetes has remained stable at approximately one-third of Americans from 2005-2008 to 2013-2016 with nearly 80% of these individuals unaware that they have prediabetes.[1] In the United States, yearly conversion from prediabetes to diabetes is estimated at a rate of 5%-10%.[4] It is important to identify individuals with prediabetes because targeted interventions can delay or prevent this progression and improve quality of life.[6]

The American Diabetes Association (ADA) provides several criteria to make the diagnosis of prediabetes to include a fasting plasma glucose (FPG) between 100 and 125 mg/dL, 2-hour oral glucose tolerance test (OGTT) with glucose results between 140 and 199 mg/dL, or hemoglobin A1c (HbA1c) range of 5.7%-6.4%.[7] The current gold standard definition of prediabetes found in the ADA Standards of Medical Care in Diabetes has been adopted by the CDC. Traditional ADA screening guidance for prediabetes has included testing

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for asymptomatic adults age ≥45 years or adults of any age who have overweight or obesity [body mass index (BMI) ≥25.0 or ≥23.0 kg/m^2 in Asian Americans] with one or more risk factors such as first-degree relative with diabetes, hypertension, high-risk ethnicity, history of CVD, HDL cholesterol <35 mg/dL, or triglyceride level >250 mg/dL.[7] However, because of the high prevalence of prediabetes and the notion that most individuals with prediabetes are not aware of having this diagnosis, the U.S. Preventive Services Task Force (USPSTF) expanded screening guidelines in 2021 to better identify those at risk.[8] These criteria now include screening all adults between the ages 35 and 70 years who are overweight, defined as BMI ≥25 kg/m^2 without needing to possess any additional risk factors. In the ADA's new revision of the Standard of Medical Care in Diabetes 2022, the screening criteria were changed to age 35 years regardless of additional risk factors.[9]

Although there have been recent studies characterizing the prevalence of diabetes, metabolic syndrome, and overweight/obesity in the active duty military force, the prevalence of prediabetes is largely unexplored and represents an area for potential improvement. A preliminary look at military health data revealed approximately 2% of service members carrying the diagnosis of prediabetes, which is markedly lower than the CDC estimate of 1/3 of the U.S. population. Although one may assume that military service members are healthier than their civilian counterparts, overweight/obesity rates are much closer than one might expect in these populations in 2008 studies (military—60.8%, civilian—68.1%).[10,11] This suggests that our prediabetes diagnosis rate is an underestimate of those actually meeting the criteria for this disease.

Therefore, the purpose of this study was to investigate the prevalence of prediabetes in military service members more fully among the Army, Air Force, and Navy. Specifically, we aimed to quantify those meeting prediabetes screening criteria, those actually being screened, and those being appropriately diagnosed.

METHODS

In consultation with the USAF Diabetes Center of Excellence, analysis explored optimizing a prediabetes definition for the Military Health System (MHS) Health Statistics project. This endeavor addressed the definition issue from a population health perspective rather than from a clinical utility approach and included International Classification of Disease, Ninth/Tenth Revisions, Clinical Modification (ICD-9) and ICD-10 diagnosis codes, specifically 790.21, 790.22, and R73.01-R73.03 along with FPG, OGTT, and HbA1c labs within the prediabetes range as defined by the ADA.

Data were analyzed from calendar years 2014 to 2018 for active duty service members 18 years of age or older and continuously enrolled to TRICARE Prime (a managed care program) or PLUS (a program allowing primary care access at MTFs) for the given calendar year.

Demographics and enrollment data were collected from the Defense Enrollment Eligibility Reporting System (DEERS), also known as TRICARE, data sources. Encounter files from Comprehensive Ambulatory/Professional Encounter Record (CAPER), Standard Inpatient Data Record (SIDR), TRICARE Encounter Data—Institutional (TED-I), and TRICARE Encounter Data—Non-Institutional (TED-NI) were mined for evidence of prediabetes and gestational diabetes diagnosis codes. Vital records were collected to obtain BMI values, and the average BMI from all records per person per year was calculated. Composite Health Care System laboratory data were queried for direct care HbA1c results as well as FPG and OGTT results. FPG and OGTT data were restricted to only results stemming from those tests occurring before 9:00 AM as a proxy in an attempt to ensure the laboratory test was conducted, while the individual was fasting.

Exclusion Criteria

Women diagnosed with gestational diabetes (ICD-9 CM code = 648.8x and ICD-10 CM code = 024x) in the measurement year were excluded. Existing data on service members' diabetes status as per National Committee for Quality Assurance Healthcare Effectiveness Data and Information Set (HEDIS) definitions were leveraged to flag whether a patient met the HEDIS-criteria for diabetes in a given calendar year for exclusion purposes.

We adhered to the prediabetes screening criteria applicable at the time the data were collected with the age cutoff of ≥45. The percentage of active duty service members meeting the criteria for prediabetes screening was determined by totaling members age 45 and older with members age 18- to 44-year old with a BMI ≥25.0 kg/m^2 and then dividing by the total number of members for each respective military branch. We acknowledge this total overestimates the percentage of active duty service members meeting prediabetes screening criteria because of the inability to ascertain whether this population had one or more risk factors. The percentage of active duty service members actually screened for prediabetes was determined based on members meeting prediabetes screening criteria who had FPG, OGTT, or HbA1c labs. The total number of labs meeting prediabetes criteria was determined based on those aforementioned labs with results in the prediabetes range. Finally, the total number of service members with an appropriate prediabetes ICD code was determined by identifying members with ICD-9 and ICD-10 codes 790.21, 790.22, and R73.01-R73.03 in their medical record.

RESULTS

From 2014 to 2018, the average active duty service members in the Air Force was 332,502 (Fig. 1). Of the 332,502 active duty service members, 53.9% met criteria for prediabetes screening. Similarly in the Army, 56.0% of the 543,081 active duty service members met prediabetes screening criteria. In the Navy, 47.3% of the 531,313 active duty service

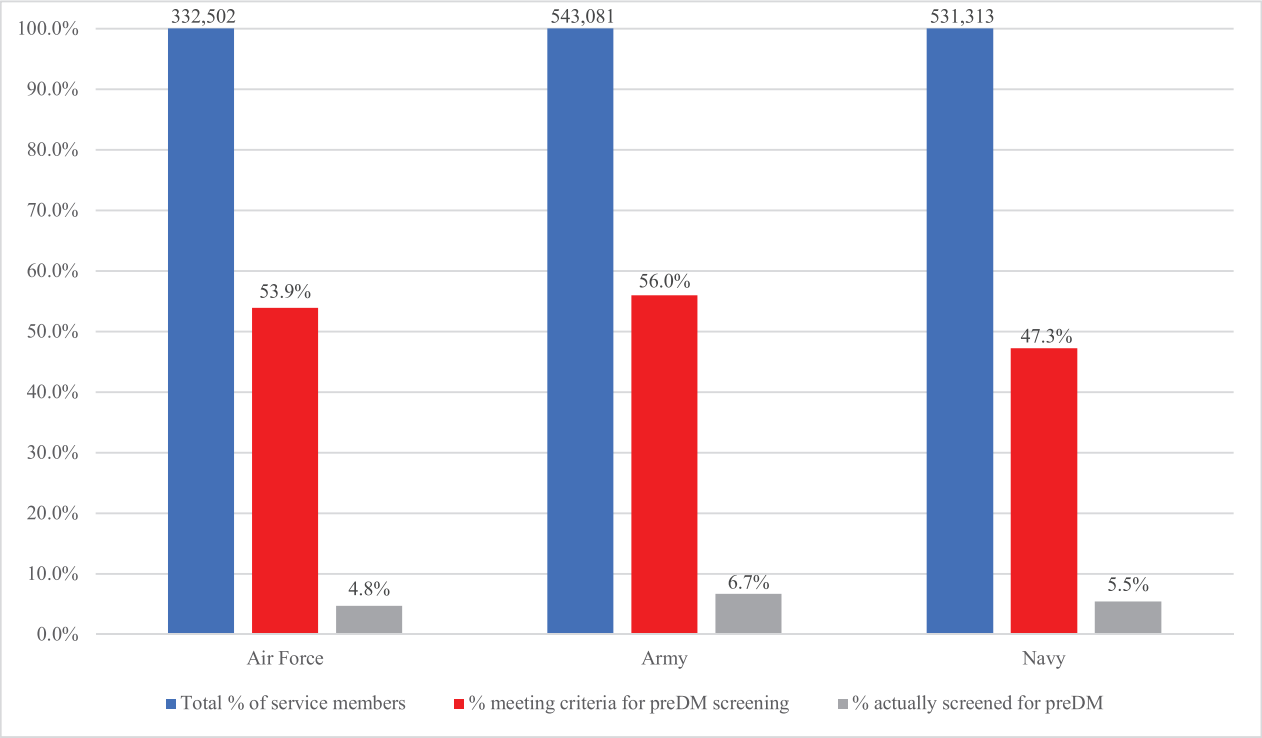

FIGURE 1. Prediabetes (preDM) screening of active duty services members from 2014 to 2018.

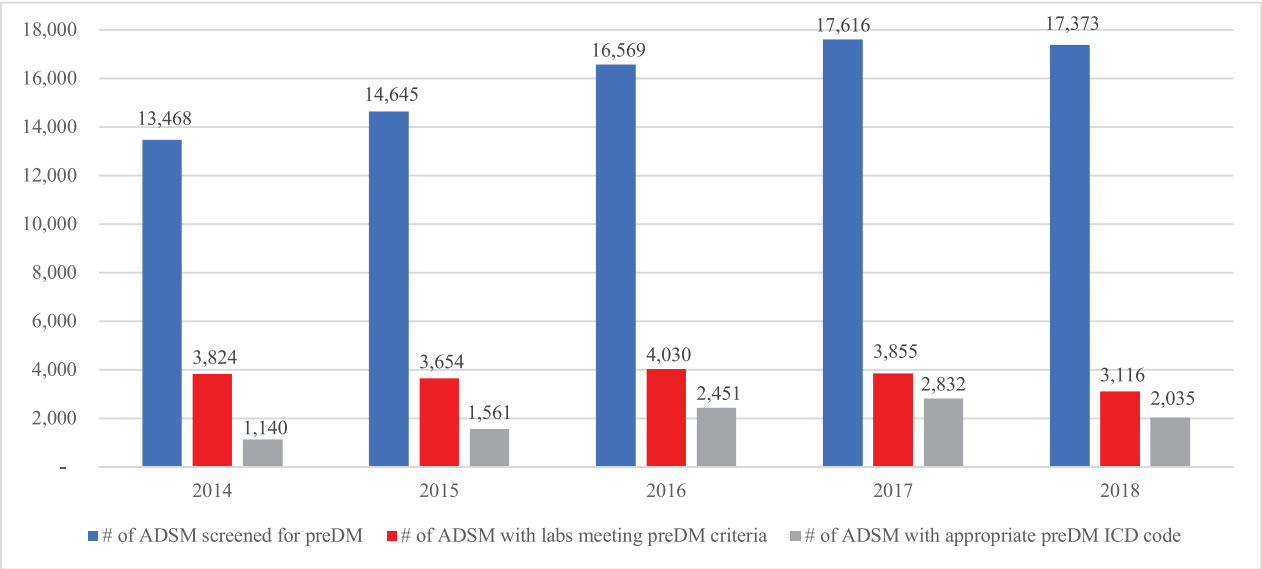

FIGURE 2. Air Force prediabetes (preDM) screening practices for active duty service members (ADSM).

members met criteria for prediabetes screening. The rates of prediabetes screening were similar across the Air Force (4.8%), Army (6.7%), and Navy (5.5%).

Of the Air Force active duty service members screened for prediabetes between 2014 and 2018, the percentage with labs meeting prediabetes criteria ranged from 17.9% to 28.4% (Fig. 2). The rate of ICD coding for prediabetes in the electronic medical record increased from 29.8% in 2014 to 65.3% in 2018.

Of the Army active duty service members screened for prediabetes each year, the percentage with labs meeting prediabetes criteria ranged from 24.2% to 30.3% (Fig. 3). The rate of ICD coding for prediabetes in the electronic medical record increased from 24.6% in 2014 to 46.8% in 2018.

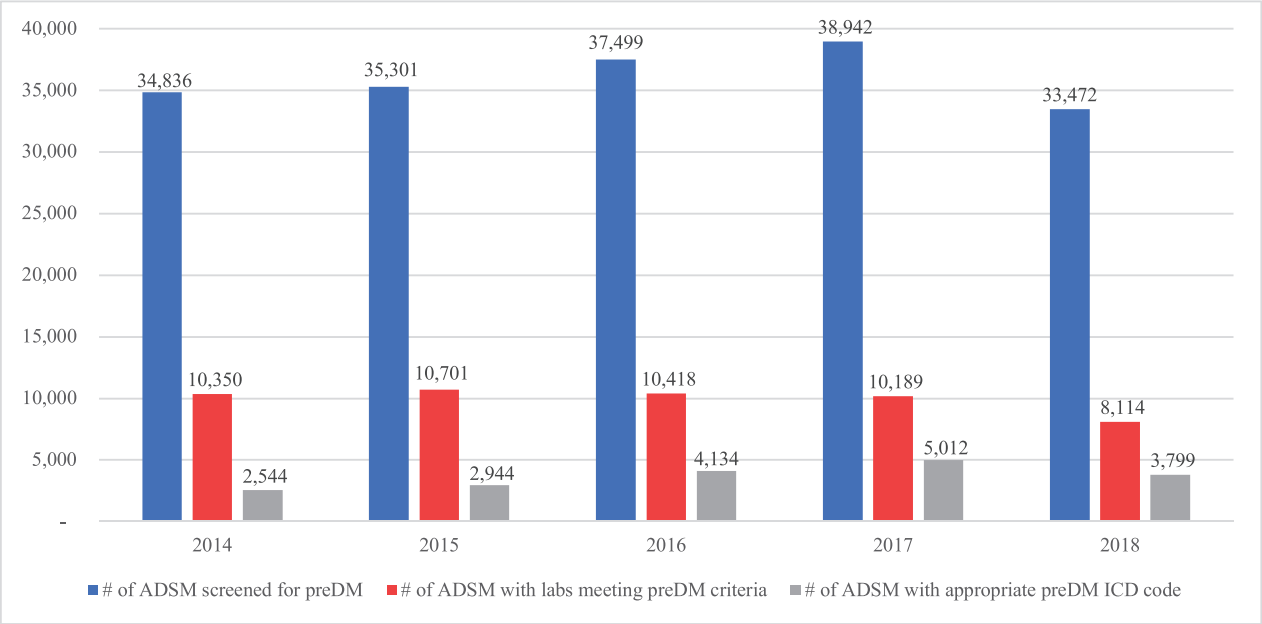

FIGURE 3. Army prediabetes (preDM) screening practices for active duty service members (ADSM).

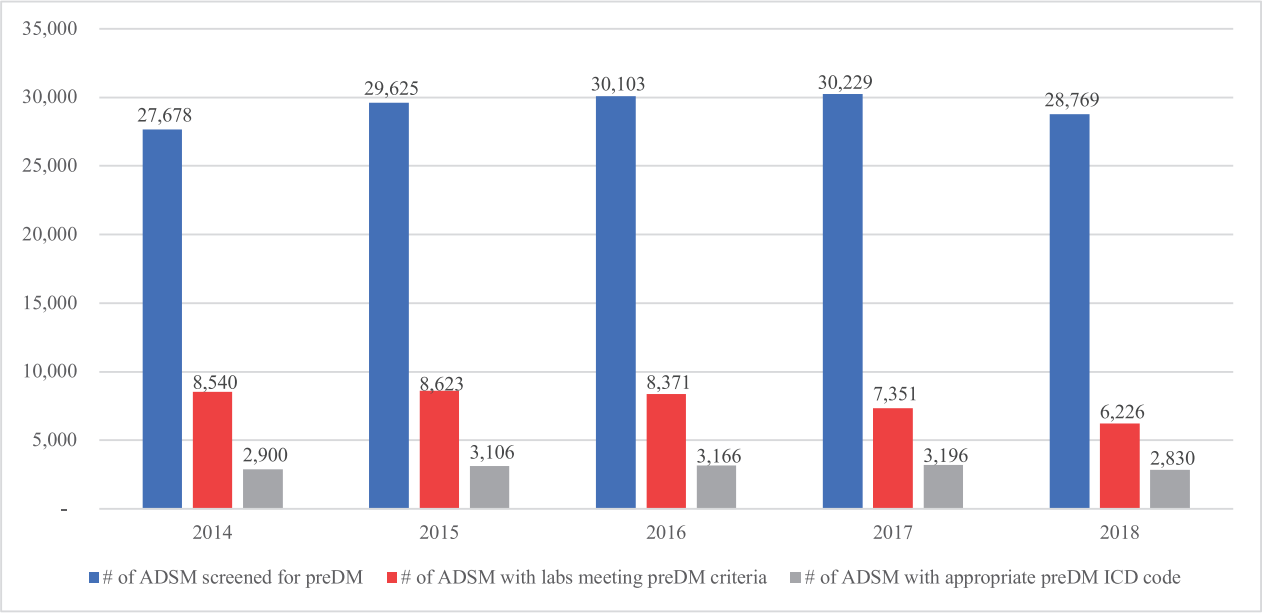

FIGURE 4. Navy prediabetes (preDM) screening practices for active duty service members (ADSM).

Of the Navy active duty service members screened for prediabetes, the percentage with labs meeting prediabetes criteria ranged from 24.2% to 30.9% (Fig. 4). The rate of ICD coding for prediabetes in the electronic medical record increased from 40.0% in 2014 to 45.5% in 2018.

DISCUSSION

This study sought to characterize screening practices for prediabetes among the three services and attempted to determine the actual prevalence of prediabetes among active duty service members. Our data set included service members continually enrolled in TRICARE Prime or PLUS with medical encounters from 2014 to 2018. Overwhelmingly, we found that prediabetes screening practices of our service members are inadequate, leaving many service members unaware of their health risks related to this condition. CDC statements about the prevalence of prediabetes in individuals without knowledge of this diagnosis suggest that this problem is not unique to the MHS, but is reflective of a problem common to medical practice at large in the United States.

The inadequacies of this problem in the MHS can be summarized as follows: a staggering percentage of the total active duty force (47.3%-56.0%) met prediabetes screening criteria. Of these, only a small percentage (4.8%-6.7% of the total force or approximately 10% of those meeting screening criteria) were actually screened with appropriate laboratory testing (FPG, OGTT, or HbA1c). Of those receiving testing, roughly a quarter met criteria for the diagnosis of prediabetes, with less than half of these receiving an actual diagnosis of prediabetes in the medical record. All of these factors lead to an annual prediabetes diagnosis rate of 2% (1.26%-2.31%) in our active duty force, but clearly this is an underestimate of this condition because of the lack of screening and diagnosing. These findings are similar across the Air Force, Army, and Navy; somewhat reassuringly, throughout the time period, there was a slight trend toward those meeting prediabetes criteria receiving an appropriate diagnosis.

The largest opportunity for improvement in the MHS is an increase in screening efforts. Although our estimates of meeting prediabetes screening criteria are overestimated by the guidelines at the time, given we were unable to obtain additional risk factors for overweight or obese members, this is still a reasonable estimate given the most recent guidelines proposed by the USPSTF and, even more so, the ADA. For example, if screening practices increased from the current screening of only 10% of members meeting prediabetes screening criteria to 100% (i.e., a 10-fold increase), then the rate of those meeting diagnostic criteria with a subsequent diagnosis might also increase 10-fold, such that the rate of prediabetes in our active duty population may be closer to 20%, rather than the 2% currently seen in the medical record. On the surface, a 20% rate is still below the CDC estimated rate of 33% for the general population, but a reasonable estimate that presumes an active duty force that is healthier than the general population.

Opportunities to improve MHS prediabetes screening practices exist with simple adjustments to current military practices. For example, the annual health assessment, public health assessment, that each service member must undergo is a series of screening questions about self-reported lifestyle behaviors and an opportunity for service members to express any concerns to their primary care teams. These assessments could be expanded to assess for overweight/obese status via an in-person vital signs visit and then, if meeting criteria, include a laboratory evaluation of either an FPG or HbA1c, all with the intention to screen for prediabetes. The routine physical fitness assessments represent another opportunity. Height and weight (and therefore, BMI) are currently recorded on each member and therefore represents another method to identify those appropriate for prediabetes screening.

As we consider that a major purpose of the MHS is to ensure a medically ready force in our active duty population, we must note that the purpose of increased screening is not to penalize service members, but rather to be postured to take steps to improve their overall health. Identifying service members with prediabetes enables targeted interventions to put our service members on a path toward their own better personal health and increased readiness for any missions they are called to pursue. Delaying or preventing the onset of actual diabetes and its myriad of complications also lowers the long-term cost burden to our medical system. Targeted interventions, like the Diabetes Prevention Program or Group Lifestyle Balance Program, have shown that structured programs for individuals with prediabetes lead to weight loss, increased exercise and up to 58% reduction in the progression to diabetes.[6,12] Efforts to increase programs like this as more service members with prediabetes are identified would be justified in the context of our larger military mission to improve readiness, decrease medical complications, and cost.

Limitations of our study include assuming services members age 18- to 44-year old with BMI $\geq$25.0 kg/m^2 had one additional risk factor (first-degree relative with diabetes, high-risk ethnicity, history of CVD, hypertension, polycystic ovary syndrome, HDL <35 mg/dL, triglyceride >250 mg/dL, or physical inactivity) that would warrant prediabetes screening, overestimating those that need screening. Another limitation is utilizing the BMI cutoff of $\geq$25 kg/m^2 to capture overweight service members when the BMI cutoff of $\geq$23 kg/m^2 defines overweight in Asian Americans. Labs performed before 9:00 AM were assumed to be fasting labs; however, this was unlikely in all cases. At the time of writing this manuscript, the ADA decreased the screening age to 35 years without risk factors.[9] Given our search criteria included adults age 45 and older, our estimate of active duty members requiring prediabetes/diabetes screening is an underestimate. Finally, estimates of the actual prediabetes prevalence in the active duty service member population were extrapolated calculations.

Future areas of study include trial adding FPG, OGTT, and HbA1c to the public health assessment at one military treatment facility for service members $\geq$35 years of age or adults with a BMI within the overweight/obese range for their ethnicity. Another area of study is to assess whether physical fitness assessment failures are risk factors for prediabetes that should prompt screening.

CONCLUSION

Screening for prediabetes in the active duty military population is grossly inadequate, and even of those screened, diagnosing those meeting prediabetes criteria is similarly inadequate. Although this scenario is not unique to the MHS, but reflective of a larger national problem, efforts should be made within the MHS to increase screening for this common disorder. Doing so will hopefully increase awareness of this issue among our active duty force and provide the basis for targeted interventions that will ultimately lead to improved health and readiness of our force.

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None declared.

CONFLICT OF INTEREST STATEMENT

None declared.

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