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Prevalence And Health Burden Of Cardiovascular Disease In Older U.s. Veterans: Results From The 2019-2020 National Health And Resilience In Veterans Study

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Prevalence and Health Burden of Cardiovascular Disease in Older U.S. Veterans: Results from the 2019-2020 National Health and Resilience in Veterans Study

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Abstract

Importance. Cardiovascular disease (CVD) is one of the leading causes of death in the U.S. and is associated with a range of demographic, military, trauma, and clinical characteristics and physical and mental health conditions. Older military veterans may have an increased risk for CVD, given their advanced age and military experiences. However, the prevalence and health burden of CVD in population-based samples has not been well characterized. **Objective.** To characterize the current prevalence of CVD, and its association with sociodemographic, military, trauma, and clinical variables in a large, contemporary, and nationally representative sample of older U.S. veterans. **Design.** Cross-sectional study of 3,001 older U.S. military veterans (age 60 and older) using data from the 2019-2020 National Health and Resilience in Veterans Study (NHRVS). **Main Outcomes.** Veterans were classified according to lifetime CVD status (CVD or no CVD [health care professional diagnoses of heart disease, heart attack, and/or stroke]). To determine the association of CVD with health status, a comprehensive range of mental and physical health variables were assessed using validated self-report assessments. **Results.** 25.5% of veterans reported having been diagnosed with CVD. Greater age, cumulative trauma burden, nicotine use disorder, and diagnoses of hypertension, high cholesterol, and diabetes were associated with CVD. CVD was independently associated with a range of mental (odds ratios [ORs]= 1.53-2.27) and physical (ORs=1.53-3.43) health conditions. **Conclusions and Relevance.** 1 in 4 older U.S. veterans reported having been diagnosed with CVD in their lifetimes. CVD was independently associated with a broad range of demographic, clinical, physical, and mental health variables in U.S. veterans, suggesting that CVD is linked to multiple health outcomes. Results

highlighted the importance of CVD for prevention and intervention efforts in the older U.S. veteran population.

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Introduction

Specific Aims & Hypotheses

The aims of this thesis are to: 1) characterize the lifetime prevalence of cardiovascular disease (CVD) among older U.S. veterans (age 60+); 2) examine sociodemographic, military, trauma, and clinical risk factors associated with self-reported CVD; 3) identify mental health conditions associated with self-reported CVD, and 4) identify physical health conditions associated with CVD.

Based on prior literature, we hypothesized that: 1) the prevalence of CVD will be higher in older U.S. veterans relative to the general older U.S. adult population; 2) older age, male gender, greater trauma exposures, and CVD risk factors such as hypertension, diabetes, and high cholesterol would be more prevalent among veterans with CVD; 3) the prevalence of self-reported CVD will be associated with elevated rates of depression, posttraumatic stress disorder, suicidality, and alcohol use problems; and 4) the prevalence of self-reported CVD will be associated with elevated rates of physical health conditions, including inflammatory conditions such as arthritis, asthma, and chronic pain.

Background and Rationale

Prevalence of Cardiovascular Disease

Epidemiologic studies have consistently found that advanced age is a robust risk factor for CVD. For example, recent data from the National Health and Nutrition Examination Survey (NHANES), which surveyed a nationally representative sample of U.S. adults, found that 19.9% and 32.2% of men aged 60-79 and 80+, respectively, had heart disease; among women, these prevalences were 9.7% and 18.8%, respectively.[1] However, while U.S. veterans are 20 years older

than their non-veteran counterparts and may thus have increased risk for CVD, nationally representative data on the prevalence of CVD in this population are lacking.

Older veterans may have an increased risk for CVD, as the effects of military service can be lifelong and affect both physical and mental well-being.[2–4] For example, a conceptual model of the impact of military service indicated that military service, especially combat exposure, is a "hidden variable in aging men," which may negatively impact the aging process, depending on the environment and sociocultural context of their experience, exposures to trauma, severity of psychological and/or physical injuries, and military stressors.[5] Indeed, a recent study of more than 150,000 participants in the National Health Interview Study found that veterans reported higher rates of cardiovascular conditions compared to non-veterans, with younger veterans (age 25 to 70) having a greater likelihood of reporting cardiovascular conditions compared to veterans over the age of 70.[5] Further, data from the Health and Retirement Study, a 20-year national prospective cohort study of more than 8,000 older U.S. adults, revealed that veterans were twice as likely as non-veterans to develop heart disease (RR = 2.00, 95% 1.69-2.35).[3] In the proposed study, we extended this prior literature by providing up-to-date estimates of the prevalence of CVD, including heart disease, heart attack, and stroke, in a contemporary, nationally representative sample of older U.S. veterans surveyed as part of the 2019-2020 National Health and Resilience in Veterans Study. Data from nationally representative samples of U.S. veterans are essential to understanding the population-based burden of CVD, as well as associated risk factors and health comorbidities.

Risk Factors for Cardiovascular Disease

Previous studies on risk for CVD have found that being older, male, Black or non-Hispanic white are predominant risk factors for CVD.[2,6] Other key CVD risk factors include diabetes (DB), hypertension (HTN) and high cholesterol (HC), with approximately 75% of CVD risk attributable to such factors.[7] A 2014 study assessing gender and racial differences in CVD risk factors in veterans found that more male veterans had HTN and DB than female veterans.[8] In addition, HC has been identified as a risk factor for mortality and cardiovascular events. A retrospective cohort study of veterans with diabetes (mean age = 62 years) receiving treatment at the Veterans Administration (VA) for elevated levels of HTN found that those with elevated systolic blood pressure (SBP) levels when starting treatment or who had been on treatment for 2 years had worse health outcomes for cardiovascular events compared to those with lower SBP levels.[9] There is also evidence pointing to the potentially protective effects of sociodemographic characteristics such as marital status, education and being non-Hispanic white.[10] To date, however, there are limited data on independent risk factors for CVD in population-based samples of older U.S. veterans. This study will contribute to this gap in the literature by examining how a broad range of sociodemographic, military, trauma, and clinical variables are associated with the prevalence of CVD in a large, contemporary, and nationally representative sample of older U.S veterans.

Cardiovascular Disease and Mental Health Conditions

Veterans who experience significant traumas or psychiatric or physical health morbidities may have greater risk for disability and CVD mortality throughout their lives. Military experiences such as combat have also been linked to increased risk for a range of psychiatric conditions.[11–13] For example, combat veterans are more than 3 times as likely as noncombat veterans to screen

positive for lifetime posttraumatic stress disorder (PTSD) and have elevated rates of PTSD, suicide attempt and chronic pain independent of sociodemographic, military, mental health factors.[10] Further, traumatic military experiences such as military sexual trauma have been linked to increased risk for mental disorders such as PTSD and depression, both of which are independent risk factors for CVD, as well as suicidality.[14,15] Finally, a 27-year time series study of more than 3.3 million deaths among older adults found that the risk of developing ischemic heart disease was significantly higher in individuals who have attempted suicide, irrespective of depression severity.[16]

Few studies to date have evaluated the relation between CVD and mental health conditions in nationally representative samples of U.S. veterans. Older veterans who fought in certain war eras, such as the Gulf and Vietnam Wars, were shown to have increased odds of experiencing depression,[17,18] which is a known risk factor for CVD.[19–21] Moreover, the psychiatric effects of military service may be experienced years later. For example, a recent prospective study of 1.52 million men and over 94,000 women receiving health care services from the Department of Veterans Affairs revealed that mental illnesses were associated with increased risk for CVD events over a 5-year time period.[22] PTSD experienced 30 years after military service has also been linked to increased risk of cardiovascular mortality.[23] PTSD and related disorders such as depression may also develop as a result of CVD or a cardiovascular event.[24,25] A recent systematic review of PTSD and CVD further highlighted that acute CVD events may not only increase risk for the development of PTSD but may also increase risk for recurring CVD events or mortality.[26] Further, data from the 2009-2010 and 2011-2012 National Health and Nutrition Examination Surveys revealed that individuals with CVD had a higher prevalence of suicidal ideation (5.4% vs. 3.6%) compared to individuals without CVD, with the highest prevalence of SI among individuals with

prior heart attack (10.6%).[27] In the proposed study, we will build on this burgeoning body of research by examining the relationship between self-reported CVD and a comprehensive range of lifetime and current mental health outcomes in a contemporary, nationally representative sample of older U.S. veterans.

Cardiovascular Disease and Physical Health Conditions

In addition to the prevalence of cardiovascular risk factors such as hypertension, diabetes, and high cholesterol, CVD may be linked to other physical health concerns, including inflammatory conditions such as asthma and arthritis, as well as chronic pain, sleep disorders, and physical disability. For instance, asthma and arthritis are two of the most prevalent inflammatory comorbidities associated with CVD.[28–31] Chronic pain may also develop as a result of CVD or a cardiovascular event. For example, a recent international population-based cohort of extended families found that those with intense coronary disorder (ICD) had 4 times the odds of having chronic pain compared to those without ICD.[32] CVD has also been linked to chronic kidney disease (CKD), with CVD often going undiagnosed in individuals with CKD.[33] CKD may also serve as an independent risk factor for cardiovascular disease, thus calling attention to the importance of monitoring and treatment of this condition.[34] CVD has also been linked to physical disability. For example, an international population-based prospective cohort study of 1,567 older adults found that pre-frailty (i.e., low physical activity level, weakness, exhaustion) was associated with increased risk of developing CVD.[35] The relation between CVD and other physical health conditions may also be mediated in part by psychiatric morbidities. For instance, PTSD has been shown to be a risk factor for CVD, which can result in disrupted sleep, nightmares, and sleep-disordered breathing.[36–38] To date, however, most studies of CVD and physical health morbidities

have focused on civilians and select physical health conditions and concerns. In the proposed study, we will extend this work to consider how CVD is linked to a broad range of physical health conditions in a large, nationally representative sample of older U.S. veterans.

In summary, data regarding the prevalence, risk factors, and burden of cardiovascular disease in contemporary samples of the general older U.S. veterans population are lacking. In the proposed study, we will address this gap in the literature by analyzing data from a contemporary, nationally representative sample of older U.S. veterans to evaluate the following aims: 1) characterize the lifetime prevalence of CVD among older U.S. veterans (age 60+); 2) examine sociodemographic, military, trauma, and clinical risk factors associated with self-reported CVD; 3) identify mental health conditions associated with self-reported CVD, and 4) identify physical health conditions associated with CVD.

Methods

Participants and Procedure

A total of 3,001 older U.S. veterans (age 60+) participated in the 2019-2020 National Health and Resilience in Veterans Study (NHRVS), which surveyed a nationally representative sample of 4,069 veterans from November 2019 to March 2020 (median completion date: November 21, 2019). Participants were recruited from KnowledgePanel®, a probability-based online survey panel operated by Ipsos, a multinational survey research company. Participant households were sampled using the U.S. Postal Service Deliver Sequence File (DSF). Participants were given internet access and computers by Ipsos when necessary. The panel is comprised of over 50,000 households that covers approximately 98% of the U.S. adult population. Panel

members who endorsed military service were eligible to complete the survey; a total of 7,860 veterans were invited to participate in the study and 4,069 completed it (51.8% participation rate). Of these, a total of 3,001 were age 60 or higher and are the focus of the current study. To permit generalizability of results to the U.S. veteran population, the Ipsos statistical team computed post-stratification weights using the following benchmark distributions of U.S. military veterans from the most recent (August 2019) Current Veteran Population Supplemental Survey of the U.S. Census Bureau's American Community Survey: age, gender, race/ethnicity, Census Region, metropolitan status, education, household income, branch of service, and years in service.[39] All participants provided informed consent prior to study participation and the VA Connecticut Health Care System Human Subjects Subcommittee approved this study. Table 1 describes all of the assessment instruments utilized in the current study.

Data Analysis

This secondary data analysis involved an evaluation of the association between self-reported CVD, and military, sociodemographic, clinical, mental health, and physical health variables in a cross-sectional sample of 3,001 older U.S. veterans. All data analyses were conducted using SAS 9.4 software. All inferential analyses were weighted (e.g., prevalences, regression analyses) and unweighted for reported raw sample sizes. Descriptive analyses were conducted to summarize demographic characteristics and the prevalence of cardiovascular disease (e.g., Table 1: *Assessment instruments used in the current study*; Table 2: Demographic, military, and clinical characteristics by self-reported cardiovascular status in older U.S. military veterans).

Aim 1. Prevalence of Cardiovascular Disease. We computed raw, unweighted frequencies, and weighted prevalences of a composite measure of self-reported CVD,[40] as well as heart disease, heart attack, and stroke for veterans aged 60+.

Aim 2. Risk factors for Cardiovascular Disease. We conducted independent-samples t-tests and χ^2 analyses to compare sociodemographic, military, and health risk (HTN, DB, HC) correlates of CVD. We then conducted a series of multivariable binary logistic regression analyses to identify independent correlates of CVD. Sociodemographic, military, and health risk (HTN, DB, HC) correlates that were associated with CVD at the $p<0.05$ level in bivariate analyses were included in this model. Odds ratios and 95% confidence intervals were computed to quantify magnitudes of associations between these variables.

Aim 3. Mental health conditions. We conducted a series of multivariable binary logistic regression analyses to examine the relation between CVD, and lifetime and current mental health conditions. Sociodemographic, military, and health risk (HTN, DB, HC) variables that differed between veterans with and without CVD at the $p<0.05$ level in bivariate analyses were adjusted for in these models; analyses of current psychiatric disorders and suicidality variables additionally adjusted for lifetime mental health conditions. Odds ratios and 95% confidence intervals were computed to quantify magnitudes of associations between CVD and mental health conditions.

Aim 4. Physical health conditions. We conducted a series of multivariable binary logistic regression analyses to examine the relation between CVD and lifetime physical health outcomes. These analyses adjusted for sociodemographic, military, and health risk (HTN, DB, HC) variables

that differed between veterans with and without CVD at the $p<0.05$ level in bivariate analyses, as well as lifetime mental health conditions. Odds ratios and 95% confidence intervals were computed to quantify magnitudes of associations between CVD and physical health conditions.

Results

The final sample included 3,001 U.S. military veterans aged 60 years and older (mean age = 73.2; SD = 7.9; range = 60-99), the majority of whom were male (96.1%) and White, non-Hispanic (85.2%). Over one quarter (N=757; 25.2%) of the sample self-reported having been diagnosed with CVD. With regard to specific CVD conditions, 19.2% (N=582) reported having been diagnosed with heart disease, 10.1% (N=290) with a heart attack, and 4.5% (N=138) with a stroke. A total 17.2% (N=523) reported being diagnosed with one of these conditions, 7.5% (N=215) with two conditions, and 0.5% (N=19) with all three conditions.

Table 2 shows the demographic, military, and clinical characteristics by self-reported CVD status. Relative to veterans without CVD, veterans with CVD were older, and more likely to identify as male and have an annual household income of <$60,000. They also reported experiencing more traumatic life events, were more likely screen positive for a lifetime nicotine use disorder and were more likely to report having been diagnosed with high blood pressure, high cholesterol, and diabetes.

In a multivariable analysis, older age, greater number of traumatic life events, lifetime nicotine use disorder high blood pressure, high cholesterol, and diabetes were independently associated with CVD.

Cardiovascular Disease and its Association with Mental and Physical Health Conditions

Table 3 shows the prevalence of mental and physical health conditions of the sample by self-reported CVD status. Relative to veterans without CVD, veterans with CVD were more likely to screen positive for current major depressive, posttraumatic stress, and generalized anxiety disorders, as well as current suicidal ideation. Prevalences of lifetime mental health disorders, and current alcohol and drug use, and gambling disorders did not differ by CVD status. Veterans with CVD were also more likely to report having been diagnosed with arthritis, cancer, chronic pain, kidney disease, sleep disorder, migraine, rheumatoid arthritis, and MCI, dementia, or Alzheimer's disease. They were also more likely to report ADL and/or IADL disability and current insomnia. In multivariable analyses, CVD was independently associated with increased odds of current major depressive, posttraumatic stress, and generalized anxiety disorders, gambling disorder, and suicidal ideation, as well as arthritis, chronic pain, kidney disease, sleep disorder, migraine, rheumatoid arthritis, MCI dementia or Alzheimer's disease, any physical disability, and insomnia.

Discussion

This study provides recent, nationally representative data on the prevalence and overall health burden associated with CVD in older U.S. veterans. We found that over a quarter of older U.S. veterans (25.2%) reported having been diagnosed with composite, self-reported CVD. Although nationally representative data on this population are limited, the observed prevalence aligns with recent data (9.7%-32.2%) observed in the general U.S. adult population aged 60 and older.[1] Of note, our finding that 1 of 4 older veterans has been diagnosed with CVD is in the higher end of this range. Given the high mental and physical health burden of CVD observed in this study, these findings underscore the public health significance of CVD in older U.S. veterans.

CVD was strongly associated with a myriad of demographic and clinical characteristics and mental and physical health conditions in our sample of older U.S. veterans, after adjusting for potential confounding variables. CVD was associated with older age, greater trauma burden, lifetime nicotine use disorder and CVD risk factors (i.e., high blood pressure and cholesterol, diabetes). In addition, CVD was associated with almost all of the current mental health conditions (e.g., major depressive disorder, PTSD, generalized anxiety disorder) assessed in this study, as well as several potentially debilitating lifetime physical health conditions (e.g., arthritis, chronic pain, sleep disorder) of those considered in this study. Results indicated that study groups did not differ based on several demographic (e.g., race and ethnicity, education marital status), military (e.g., number of military deployments, enlistment status, years spent in the military) and clinical characteristics (e.g., adverse childhood experiences, lifetime major depressive disorder and or PTSD). Although temporality cannot be determined from our cross-sectional study results, these findings are consistent with previous studies, which have shown that CVD is associated with a broad range of demographic and health characteristics among older adults and provide further evidence that this population may particularly benefit from systematic surveillance efforts and timely interventions.[41–43]

Greater trauma burden was an independent correlate of CVD in this study. Two pathways may explain this relationship. First, a biological pathway implicating greater traumatic stress and dysregulation of the stress response systems may act as the catalyst for adverse health outcomes such as CVD. For example, traumatic experiences may inundate bodily systems with stress hormones, negatively impact the brain, and increase inflammation thus leading to adverse health outcomes.[44,45] Additionally, acute stress induced by traumatic experiences may directly affect heart rate, blood pressure, and influence the onset of cardiac cell death and thus lead to potentially

detrimental cardiac events.[46] Second, a behavioral pathway, whereby engaging in risky or poor health behaviors, may link trauma and health outcomes such as CVD.[44–46] Prospective cohort studies of adults with CVD have found that greater trauma exposures may predict unhealthy behaviors such as smoking, nicotine use, tobacco use, or other drug use, unhealthy dietary practices, and physical inactivity, all which can increase risk for chronic health conditions – particularly a 38% increased risk for adverse CVD outcomes.[47,48] These pathways have important clinical relevance for older U.S. veterans, who may experience greater psychological and physical distress due to traumatic exposures during military experience.[11–15]

Results of the current study confirm the well-known association between CVD risk factors such as hypertension, high cholesterol, and diabetes, and CVD. They extend this link to older U.S. veterans and underscore the importance of targeting these risk factors as part of primary and secondary prevention and treatment efforts in this population. Previous studies have demonstrated that individuals with underlying health conditions such as diabetes have an increased risk for CVD. For example, a matched case-control study of veterans with diabetes demonstrated that older patients have increased risk for developing diabetes, with CVD as a complication of the condition in approximately 50% of cases.[49] As diabetes may be asymptomatic at the onset, this prevalence may be explained by lack of control and management of diabetes, a delay in diagnosis, or availability of screening and quality of care.[49] Moreover, as diabetes is associated with a higher risk for CVD, it may further be exacerbated by hypertension due to inflammation, insulin resistance, and activation of the immune system. [50] Across all ages and age groups, hypertension has been shown to have an independent association with CVD events such as stroke, myocardial infarction, heart failure, or even sudden death.[51] It is therefore urgent that older veterans with hypertension be screened, monitored, and have access to life-saving care. High cholesterol may

also play an influential role in CVD in older veterans and may be attributed to western lifestyle and dietary patterns. This may result in an increase in plasma accumulation in the arteries, lesions, and plaque, which may cause coronary heart disease and ischemic stroke.[52] Consequently, these clinical characteristics may require greater health care utilization and generate higher health care costs.

Results of this study also suggest that CVD was associated with elevated likelihood of several current mental health conditions and suicidal thinking. For example, even with conservative adjustment for demographic and trauma characteristics, as well as lifetime mental health conditions, CVD was associated with a 2-fold greater likelihood of screening positive for major depressive disorder (MDD) and a nearly 2-fold greater likelihood for PTSD and generalized anxiety disorder (GAD). In addition, our study found no association between CVD and lifetime mental health conditions, thus suggesting that CVD may lead to development and diagnosis of current mental health conditions. These results are consistent with previous studies, which have shown that depression, PTSD, and anxiety may be a direct consequence of a cardiac event (including stroke). European meta-analyses, cross-sectional and observational studies of older U.S. adults ($\geq$ 71 years) have shown that after a clinical stroke diagnosis, 29.3% of patients had some form of anxiety disorder one during the first year and 42.2% of patients experienced depression six months after the event.[42,53] This may be explained by dissatisfaction with the availability of mental health services, physical or cognitive disability resulting from the stroke, or psychological and financial burdens.[42,53] Moreover, it is important to consider the bidirectional nature of this association and possible mechanism of cardio-pathogenesis. Anxiety or panic disorder symptoms may exacerbate underlying coronary disease, overlap with coronary heart disease symptoms, and increase creatinine kinase and intraoperative glucose levels.[54] As

mentioned above, behavioral factors such as smoking, nicotine use, and avoidance of physical activity may further contribute to this association. [55–57] Individuals with CVD may develop MDD as a consequence of sedentary behavior, which may occur as a form of maladaptive coping and denial of dealing with CVD; sedentary behavior has been found to be associated with increased risk of CVD and all-cause mortality.[58,59] The association between CVD and depression may further be explained by the "vascular disease hypothesis," whereby vascular disease may predispose, precipitate, or perpetuate depressive symptoms in older adults.[60] With regard to PTSD, a recent study revealed that medications may serve as traumatic reminders of previous CVD or stroke events and thus cause aversions toward medication adherence due to feelings of nervousness, anxiousness, and anticipation of future adverse events. [61] In fact, veterans with PTSD have been found to be more likely to report nonadherence to preventative medications.[62] A retrospective cohort study of aging veterans (≥ 55 years) further noted the longitudinal impact of PTSD on incident CVD. Even after adjustment for potential confounders, veterans with late-life PTSD had a 45% increased risk for CVD compared to veterans without late-life PTSD, therefore requiring close monitoring and treatment of these mental health conditions.[63]

Results of multivariable analyses further revealed that older veterans who reported have been diagnosed with CVD had more than 50% elevated odds of current gambling disorder and suicidal ideation. The observed link between CVD and gambling disorders aligns with a study that analyzed data on adults aged 55 and older who participated in the National Epidemiologic Survey of Alcohol and Related Conditions (NESARC). In this study, at-risk/problem/pathological gambling (ARPG) was prospectively associated with increased incidence of arteriosclerosis or any heart condition, after controlling for sociodemographic, psychiatric conditions, and substance use covariates.[64] This association may also be understood in the context of "self-determination" theory

(SDT) for gambling motivations. Older individuals may desire autonomy, fulfillment, and increased life-satisfaction and thus utilize gambling as a "maladaptive strategy" to address these needs.[65] Additionally, they may view gambling as recreational outlet or form of entertainment and socialization, especially if unable to participate in physically demanding leisure activities due to declining health status.[65] The association between CVD and suicidal ideation in older veterans may be a result of high levels of worry, fear, apprehension about the future, lack of motivation or ability to concentrate, risk of nonadherence to medications, or physical difficulty participating in rehabilitation programs.[66] This association may further be explained by elevated rates of internalizing psychopathology such as depression, PTSD, and GAD, as well as chronic pain and functional disability observed in veterans with CVD. Indeed, previous studies have found that chronic physical pain associated with CVD may lead to suicidality as a consequence of social isolation, life stress, loss of autonomy and dignity, perceptions of uselessness, increased burden on social networks and physical impairments.[67,68] Taken together, these findings highlight the importance of routinely screening and monitoring suicide risk in older veterans with and at risk for CVD.

Relative to veterans who did not report having been diagnosed with CVD, veterans who reported CVD were more likely to report being diagnosed with almost all of the physical health conditions assessed. Multimorbidity has been deemed "endemic" among the older population, particularly those with CVD.[69] More than 70% of adults develop CVD by the age of 70 years old, of which more than 65% develop non-CVD comorbidities.[69] This may be in part due to disease-disease interactions (e.g., chronic kidney disease, hypertension, heart failure), disease-drug interactions (e.g., heart failure and arthritis medications), and drug-drug interactions (e.g., medication for one medical condition weakening another).[69] The lower observed prevalence of

CVD (25%) in the current study may be partly accounted for by lack of or reduced health care access, reluctance to seek or underutilization of medical care, or mismanagement of physical health conditions such as the ones mentioned above. This may present difficulties in disease management for health care providers and patients and therefore require innovative approaches to medical care. Non-CVD multimorbidity has been found to be associated with increased symptoms and symptom burden than CVD comorbidities.[70] A recent cross-sectional study on the impact of multimorbidity on health-related quality of life of patients with CAD found that multimorbidity has a negative effect on both physical and mental health, thus requiring need for dire treatment and disease management.[71,72]

Another important physical health issue to consider for older veterans with CVD is insomnia and sleep disturbance. Sleep disturbances have been found to be independently associated with worse CVD outcomes, with epidemiological studies suggesting that sleep disorders such as sleep apnea are causally linked to CVD and stroke.[73,74] Further, a meta-analysis of 13 prospective cohort studies demonstrated that those with insomnia have 1.45 times the risk of developing or dying from CVD compared to those without insomnia, for it may contribute to poor mental health (e.g., depression) or decreased quality of life.[75] Moreover, for patients recovering from a cardiac event, sleep disturbances have been associated with poor medication adherence, worse mental health (e.g., anxiety, depression) and an obstacle to rehabilitation efforts.[75]

Limitations of this study must be noted. First, while nationally representative, the sample predominantly consisted of older, male, non-Hispanic white veterans, which may limit generalizability of findings to more demographically diverse samples of veterans. Second, this study is a secondary analysis of cross-sectional data, which does not allow us to make causal links or inferences between CVD and associations with variables of interest. Third, CVD was assessed

using a self-report measure that inquired about health care professional-diagnosed conditions; given a greater reluctance to seek health care services in older men[76] and thus lower likelihood of receiving a diagnosis of CVD (i.e., heart disease), it is possible that the observed prevalence may reflect an underestimate of the population-based burden of CVD. Further studies are needed to corroborate study findings, particularly longitudinal studies that may help determine temporality or casual linkages between CVD and mental and physical health outcomes.

Conclusion

This study provides novel insights about the prevalence and health burden of CVD in a contemporary, nationally representative sample older U.S. veterans. The prevalence of CVD (25.2%) found in our study sample underscores the importance of monitoring and screening veterans who may have risk factors for CVD, particularly given concerns related to lower access to quality care, delays in screening, reluctance to seek care, or mismanagement of multiple comorbidities in older veterans. Our finding that CVD is associated with a broad range of mental and physical health conditions in older U.S. veterans highlights the importance and urgency of recognizing CVD as a priority for prevention and treatment efforts in this population. Public health interventions in clinical and community settings may help reduce the physical, mental, and financial burden on older U.S. veterans.[71] New, innovative approaches to providing quality care to this population, such as internet-based approaches or mobile health interventions that focus on patient-centered care (e.g., stress management, mindfulness, self-monitoring), and collaboration across multiple health systems may be helpful.[70,72,77,78] Results of the current study also underscore the importance of screening, monitoring, and treating the high prevalence of risk factors and other health conditions that are concomitant with self-reported CVD in older U.S. veterans. Further

research comprised of more diverse samples that employ longitudinal and mechanistic research designs are needed to examine the prevalence of and bidirectional associations of CVD with demographic, military, and clinical characteristics. Additional research is also needed to evaluate the effectiveness of individual-, societal-, and policy-level interventions and prevention strategies in mitigating the physical, mental, and socioeconomic burdens of CVD and related multimorbidities among older veterans and other at-risk populations.

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Appendix

Table 1. *Assessment instruments used in the current study*

Assessments
Cardiovascular Disease (CVD) Status CVD status assessment.[40] Response of "yes" to: "Has a doctor or healthcare professional ever told you that you have heart disease; has a doctor or healthcare professional ever told you that you have had a heart attack; has a doctor or healthcare professional ever told you that you have had a stroke?" is indicative of a positive screen for CVD.
Current Psychiatric History Current PTSD assessed by the PTSD Checklist for DSM-5 (PCL-5);[79] Score ≥33 was indicative of a positive screen for PTSD. Current MDD assessed by the Patient Health Questionnaire-2 (PHQ-2);[80] Score ≥3 was indicative of a positive screen for MDD. Current GAD assessed by the Generalized Anxiety Disorder-2 (GAD-2);[81] Score ≥ 3 was indicative of a positive screen for GAD. Current AUD assessed by the Alcohol Use Disorder Identification Test (AUDIT);[82] Score ≥ 8 was indicative of a positive screen for AUD. Current DUD assessed by the Screen of Drug Use;[83] Response of ≥ 7 days is indicative of a positive screen for DUD; Response of 6 or fewer or response of ≥ 2 days to the question "How many days in the past 12 months have you used drugs more than you meant to?" is indicative of a positive screen for DUD.
Lifetime Psychiatric and Substance Use Disorder History Lifetime PTSD assessed by the PTSD Checklist for DSM-5 (PCL-5);[79] Score ≥ 33 was indicative of a positive screen for PTSD. Lifetime MDD, AUD, and DUD were assessed by the Mini-International Neuropsychiatric Interview. [84] Standard DSM-5-based algorithms were used to identify positive screens for these disorders. Lifetime nicotine use disorder was assessed using the Fagerström Test for Nicotine Dependence;[85] Score ≥ 6 was indicative of a positive screen for NUD.
Suicidality Current SI: Endorsement of "several days or more" in response to item 9 ("How often have you been bothered by thoughts that you would be better off dead; and/or thoughts of hurting yourself in some way over the past 2 weeks") on the Patient Health Questionnaire-9 (PHQ-9)[86] Lifetime suicide attempt: Response of "yes" to the item: "Have you ever tried to kill yourself?"
Physical Health Conditions

Total of 18 different medical conditions assessed by the item: "Has a doctor or healthcare professional ever told you that you have any of the following medical conditions?" (e.g., arthritis, cancer, diabetes, kidney disease).

Activities of daily living (ADL) disability assessed by the item: "At the present time do you need help from another person to do the following (e.g., bathe, walk around home or apartment)?"[87]

Instrumental activities of daily living (IADL) disability assessed by the item: "At the present time do you need help from another person to do the following (e.g., pay bills or manage money)?"[87]

Adverse Childhood Experiences and Trauma Exposures

Count of potentially traumatic events on the Life Events Checklist for DSM-5.[79]

Score on Adverse Childhood Experiences Questionnaire.[88]

Gambling Use Disorder

Brief Problem Gambling Screen.[89] Response of "yes" to one or more of the following questions is indicative of a positive screen for problem gambling: "In the past 12 months would you say you have been preoccupied with gambling; have you needed to gamble with larger amounts of money to get the same feeling of excitement; have you often gambled longer, with more money or more frequently than you intended to; made attempts to either cut down, control or stop gambling; borrowed money or sold anything to get money to gamble?"

Table 2. Demographic, military, and clinical characteristics by self-reported cardiovascular disease status in older U.S. military veterans

	Cardiovascular Disease N=757 Weighted 25.2%	**No Cardiovascular Disease** N=2,244 Weighted 74.8%	**Test of difference** **(χ^2 or t)**	**p**	**Multivariable analysis comparing CVD to no CVD**
	Weighted mean (SD) or n (weighted %)	Weighted mean (SD) or n (weighted %)			OR (95%CI)
Demographic Characteristics					
Age	75.7 (7.9)	72.4 (7.8)	8.99	<.001	1.06 (1.05-1.08)***
Sex			5.30	0.021	
Male	728 (97.7%)	2,063 (95.6%)			1.17 (0.64-2.14)
Female (ref)	29 (2.3%)	181 (4.4%)			
Race/ethnicity			0.70	0.87	-
Non-Hispanic white	664 (85.7%)	1,933 (85.1%)			
Non-Hispanic black	32 (7.6%)	129 (8.4%)			
Hispanic	38 (3.8%)	120 (3.4%)			
Other	23 (2.8%)	62 (3.1%)			
Education			0.16	0.69	-
Some college or less	412 (67.4%)	1,194 (66.5%)			
College graduate or more	345 (32.6%)	1,050 (33.5%)			
Marital status			0.82	0.36	-
Never married/divorced/separated	220 (27.3%)	620 (25.4%)			
Married/partnered	537 (72.7%)	1,624 (74.6%)			
Annual household income			6.57	0.010	

≤ $60K	360 (49.0%)	964 (43.0%)			
> $60K (ref)	397 (51.0%)	1,280 (57.0%)			0.86 (0.71-1.05)
Military Characteristics					
Number of deployments			2.96	0.23	-
No deployments	500 (69.1%)	1,550 (70.7%)			
One deployment	154 (19.0%)	460 (19.9%)			
Two or more deployments	96 (11.9%)	217 (9.4%)			
Enlistment status			2.72	0.26	-
Enlisted	553 (70.3%)	1,606 (72.1%)			
Drafted	127 (20.4%)	352 (17.6%)			
Commissioned	76 (9.3%)	284 (10.4%)			
10+ years in military	248 (30.5%)	719 (30.2%)	0.01	0.90	-
Clinical Characteristics					
Adverse childhood experiences	1.2 (1.7)	1.1 (1.6)	0.70	0.48	-
Total traumas	8.6 (7.6)	7.5 (7.6)	3.03	0.002	1.03 (1.01-1.04)***
Lifetime MDD and/or PTSD	125 (15.8%)	322 (15.0%)	0.19	0.66	-
Lifetime AUD and/or DUD	311 (39.2%)	858 (39.5%)	0.02	0.89	-
Lifetime NUD	171 (23.3%)	364 (17.7%)	9.16	0.002	1.39 (1.09-1.77)**
High blood pressure	541 (72.4%)	1,263 (58.3%)	38.00	<.001	1.35 (1.08-1.68)**
High cholesterol	516 (67.5%)	1,122 (50.0%)	56.06	<.001	1.74 (1.40-2.15)***
Diabetes	271 (36.8%)	471 (21.5%)	55.71	<.001	1.86 (1.50-2.29)***

Note. MDD=major depressive disorder; PTSD=posttraumatic stress disorder; AUD=alcohol use disorder; DUD=drug use disorder; NUD=nicotine use disorder.

Table 3. Mental and physical health conditions by self-reported cardiovascular disease status in older U.S. military veterans

	Cardiovascular Disease N=757 Weighted 25.2%	**No Cardiovascular Disease** N=2,244 Weighted 74.8%	**Test of difference (X^2 or t)**	**p**	**Multivariable analyses comparing CVD to no CVD**
	N (weighted %)	N (weighted %)			OR (95%CI)
Lifetime					
Major depressive disorder	91 (10.0%)	219 (9.0%)	0.51	0.47	1.20 (0.87-1.67)
Posttraumatic stress disorder	58 (6.9%)	154 (6.8%)	0.01	0.92	1.13 (0.75-1.70)
Alcohol use disorder	296 (37.2%)	817 (37.8%)	0.08	0.77	0.96 (0.79-1.17)
Drug use disorder	67 (8.6%)	205 (9.7%)	0.60	0.44	1.08 (0.77-1.52)
Suicide attempt	14 (1.5%)	43 (1.5%)	0.00	0.96	1.19 (0.54-2.63)
Current					
Major depressive disorder	52 (7.2%)	79 (3.4%)	15.47	<.001	2.27 (1.50-3.45)***
Posttraumatic stress disorder	37 (4.5%)	64 (2.7%)	4.01	0.045	1.91 (1.12-3.25)*
Generalized anxiety disorder	34 (4.5%)	59 (2.7%)	5.04	0.025	1.75 (1.06-2.89)*
Alcohol use disorder	58 (7.7%)	166 (7.7%)	0.00	0.98	1.24 (0.86-1.77)
Drug use disorder	52 (7.7%)	137 (6.2%)	1.53	0.22	1.65 (1.13-2.42)**
Gambling disorder	40 (6.2%)	82 (4.3%)	3.75	0.053	1.53 (1.01-2.32)*
Suicidal ideation	57 (6.5%)	104 (4.2%)	5.35	0.021	1.54 (1.01-2.35)*
Lifetime					
Arthritis	367 (47.3%)	907 (39.8%)	10.43	0.001	1.27 (1.04-1.53)*
Asthma, chronic bronchitis, or COPD	115 (13.4%)	264 (11.4%)	1.83	0.18	1.14 (0.86-1.51)
Cancer	217 (28.7%)	551 (24.0%)	5.25	0.022	1.07 (0.86-1.33)

Chronic pain	229 (27.6%)	475 (20.4%)	13.62	<.001	1.48 (1.18-1.85)**
Liver disease	17 (1.8%)	40 (1.7%)	0.05	0.81	1.32 (0.65-2.69)
Kidney disease	104 (14.4%)	110 (4.4%)	69.93	<.001	3.43 (2.47-4.77)***
Sleep disorder	242 (29.3%)	494 (22.0%)	13.13	<.001	1.51 (1.21-1.88)***
Migraine	61 (6.6%)	115 (4.4%)	4.92	0.027	1.53 (1.02-2.31)*
Osteoporosis or osteopenia	56 (5.8%)	142 (4.5%)	1.74	0.19	1.38 (0.90-2.12)
Rheumatoid arthritis	69 (9.0%)	121 (5.6%)	8.13	0.004	1.56 (1.10-2.22)*
Concussion or traumatic brain injury	43 (5.1%)	104 (4.0%)	1.33	0.25	1.44 (0.92-2.27)
MCI, dementia, or Alzheimer's disease	23 (3.8%)	34 (1.4%)	13.32	<.001	2.21 (1.23-3.98)**
Any Physical Disability	175 (24.5%)	254 (12.0%)	54.71	<.001	1.95 (1.54-2.49)***
ADL disability	61 (8.8%)	93 (4.4%)	16.38	<.001	1.70 (1.17-2.46)**
IADL disability	163 (22.7%)	234 (11.1%)	49.67	<.001	1.92 (1.49-2.46)***
Insomnia			16.24	<.001	
Subthreshold Insomnia	205 (26.3%)	493 (21.7%)			1.37 (1.10-1.72)**
Clinical Insomnia	80 (8.9%)	133 (5.6%)			2.08 (1.44-3.00)***

Note. COPD=chronic obstructive pulmonary disease; MCI=mild cognitive impairment; ADL=activities of daily living; IADL=instrumental activities of daily living.

Analyses of lifetime psychiatric variables are adjusted for age, gender, household income, and cumulative lifetime trauma burden; Analyses of current psychiatric disorders, suicide attempt and ideation, and physical health variables are additionally adjusted for lifetime MDD, PTSD, AUD, NUD, and DUD.