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U.S. military service and the prevalence of metabolic syndrome: Findings from a cross-sectional analysis of the Cooper Center Longitudinal Study, 1979–2013

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ABSTRACT

U.S. military service confers both health benefits and risks potentially associated with a clustering of cardiovascular risk factors called metabolic syndrome. However, the association between prior military service and metabolic syndrome has not sufficiently been examined. The purpose of the study was to compare the prevalence of metabolic syndrome by prior military service status. Among 42,370 men (887 with prior military service) examined from 1979 to 2013 at the Cooper Clinic (Dallas, TX), we used a cross-sectional study design to examine the association between military service and metabolic syndrome. First, an unadjusted log binomial regression model was performed by regressing the prevalence of metabolic syndrome on prior service. This was followed by performing Kleinbaum's modeling strategy for assessing confounding. The same methodology was used to explore the association between individual metabolic syndrome risk factors and prior service. Prior military service was not significantly associated with the prevalence of metabolic syndrome (PR = 0.98, 0.89–1.07). None of the variables explored were identified as confounders. Participants with prior military service had lower prevalence of both elevated levels of triglycerides (PR = 0.89, 0.80–0.99) and low levels of high-density lipoprotein-cholesterol (PR = 0.78, 0.70–0.88). They had a higher prevalence of elevated resting systolic blood pressure (PR = 1.23, 1.12–1.35). However, none of these associations were significant after adjusting for identified confounders: age; cardiorespiratory fitness; and exam year. Study findings indicate that military service was not independently associated with the prevalence of metabolic syndrome or its components. Future research is warranted longitudinally assessing the impact of military service on long-term outcomes.

1. Introduction

The United States (U.S.) Armed Forces is a national and occupational institution (Moskos, 1977) requiring military service members to exhibit both self-sacrifice and a willingness to serve their country. Meeting these required service obligations confers both benefits and risks such as: increased fitness resulting from compulsory physical activity (Littman et al., 2013); specialized training (Segal and Segal, 2004); injuries from physical training (Canham-Chervak et al., 2010; Jones et al., 2010); exposure to negative health behavior norms such as cigarette smoking (Joseph et al., 2005; Smith and Malone, 2009a; Smith and Malone, 2009b); and the potential repeated exposure to combat-related stress (Reger et al., 2009; Vasterling et al., 2010). Service members' potential exposure to these factors and adoption of these behaviors may persist across the life-course (Gilpin et al., 2005; Beunen et al., 2004; Barnekow-Bergkvist et al., 1998; Cook, 2001; Hunt and Robbins, 2001; Aldwin et al., 1994), because they occur during the critical developmental period of early adulthood. Therefore, long after completion of these service obligations, protective and risk factors associated with military service have the potential to alter long-term health outcomes of veterans (Settersten, 2006; Chatterjee et al., 2009; MacLean and Elder, 2007; Elder et al., 1997; Wilmoth et al., 2010). However, the association between military service and long-term outcomes remains complicated (Spiro et al., 2016). Despite the relative healthy status of service

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members required to meet service requirements, numerous studies have reported deleterious effects of long-term physical and mental health for service members exposed to combat trauma (Settersten, 2006). Further complicating matters is the military resilience hypothesis that some veterans remain resilient after experiencing combat trauma and maybe protected from long-term physical and mental health outcomes while other veterans do not(Pietrzak and Cook, 2013; Pietrzak et al., 2010; Simmons and Yoder, 2013).

Metabolic syndrome is a clustering of cardiometabolic risk factors associated with an increased risk of the following outcomes: cardiovascular disease; type 2 diabetes mellitus; certain cancers; and all-cause mortality (Ford, 2005; Mottillo et al., 2010; Thomas et al., 2010; Esposito et al., 2012). Metabolic syndrome is associated with several other factors including: sociodemographics (e.g. older age, low household income, low educational attainment) (Park et al., 2003; Silventoinen et al., 2005; Ervin, n.d.); health behaviors (e.g. smoking, physical inactivity) (Park et al., 2003; Ford et al., 2005) and neuropsychiatric outcomes (e.g. depression, generalized anxiety disorder, post-traumatic stress disorder (PTSD)) (Dunbar et al., 2008; Heppner et al., 2009; Carroll et al., 2009). Importantly, many of these factors are also independently associated with military service (Littman et al., 2013; Feigelman, 1994; McKinney et al., 1997; Richardson et al., 2010; Buis et al., 2011; Hoerster et al., 2012). Because of the high estimated cost attributed to these long-term outcomes (Yoon et al., 2011; Zulman et al., 2015) and the potential impact these chronic conditions have on quality of life (Kazis et al., 1998) and productivity (Zhang et al., 2016), metabolic syndrome is a health outcome of growing public health concern among veterans. Therefore, prior military service has the potential to influence the development of metabolic syndrome across the life-course; and elucidating how these factors influence the association between military service and metabolic syndrome is important in order to target health promotion strategies specific to the veteran population.

This study investigated the possible association between service-related factors and metabolic syndrome. Using a large sample from the Cooper Center Longitudinal Study (CCLS), this study had two primary aims. The first aim was to compare the prevalence of metabolic syndrome among men reporting and not reporting prior military service. The second aim was to explore the role of available confounders in the following categories: sociodemographics, health behaviors, neuropsychiatric health, and clinical factors on the association between prior military service and metabolic syndrome.

2. Methods

2.1. Study design and participants

Using data collected from the CCLS from 1979 to 2013, we used a cross-sectional study design to examine the association between military status and metabolic syndrome (and individual components). We used data from 1979 to 2013 because this was the time period when all individual criteria for a diagnosis of metabolic syndrome were collected in the CCLS. The CCLS is an ongoing study of adults who come to the Cooper Clinic (Dallas, Texas) for a preventive medical visit and enroll in the study. The Cooper Clinic is a fee for service preventive medical clinic with participants that are generally well educated, non-Hispanic white, and from middle to upper socioeconomic strata. Participants included in the current study are men who visited the Cooper Clinic for a preventive medical exam at least once from 1979 to 2013. Women and unemployed participants were excluded. The unemployed were excluded due to the small sample of this stratum; and women were excluded because no women indicated prior military service. Data were analyzed from 2015 to 2016.

2.2. Dependent variables

2.2.1. Metabolic syndrome

Diagnosis of metabolic syndrome was based on criteria from the National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III) (Grundy et al., 2005). The NCEP ATP III requires three or more of the following five criteria for a diagnosis of metabolic syndrome in men: (1) waist circumference ≥ 102 cm; (2) triglyceride level ≥ 150 mg/dL; (3) high density lipoprotein cholesterol (HDL-C) < 40 mg/dL; (4) systolic blood pressure ≥ 130 mm Hg or treatment with antihypertensive medications; (5) diastolic blood pressure ≥ 85 mm Hg; and (6) fasting glucose ≥100 mg/dL or treatment with diabetic medications (Grundy et al., 2005; Grundy et al., 2004). Since medication history was not available in the CCLS dataset, we adhered to an approach used in previous CCLS studies (LaMonte et al., 2005; Shuval et al., 2012; Grundy et al., 2012) and utilized either self-reported history of hypertension/diabetes or laboratory data to determine if each criterion was satisfactorily met. Participants were classified as meeting or not meeting the criteria for metabolic syndrome. The six individual metabolic syndrome risk factors listed above were also individually modeled as dichotomous dependent variables (met/not met).

2.2.2. Tension and anxiety

Participants' tension and anxiety levels were categorized based on their response to the CCLS Medical History Question tension and anxiety scale. Participants indicating the following three responses were classified as having high tension and anxiety: “moderate tension”; “high tension”; or “very tense”. Conversely, participants reporting either “no tension” or “slight tension” were classified as having no tension and anxiety.

2.3. Independent variables

The five categories of variables explored as potential confounders of the association between prior military service and metabolic syndrome were: sociodemographic; health promoting; health compromising; neuropsychiatric; and clinical variables. All non-clinical variables used in this study were self-reported via the CCLS Medical Health Questionnaire. The specific details of the Cooper Clinic's standardized manual of operations for clinical examinations performed after a 12-hour fast are described elsewhere (Blair et al., 1989); but a brief review of the methodology for measuring cardiorespiratory fitness is provided below.

Cardiorespiratory fitness was determined using a symptom-limited graded maximal treadmill exercise test. A modified Balke protocol (Blair et al., 1989) was used to estimate maximal aerobic capacity (VO_2max). Maximal metabolic Equivalent of Tasks (METs; 1 MET = 3.5 mL oxygen uptake · kg body mass^{-1} · min^{-1}) was used as a valid estimate of measured VO_2max. VO_2max was estimated based on both the final treadmill speed and grade (Pollock et al., 1976; Pollock et al., 1982). Cardiovascular fitness was categorized as low (<10 METS), moderate (≥10–12.5 METS), and high fitness (>12.5 METS) based on sample tertiles of VO_2max.

2.4. Statistical methods

Continuous variables were considered normal because of the central limit theorem where $n \geq 30$ (Rosner, 2011). Furthermore, both the mean and standard deviation were reported stratified by prior military service status. For categorical variables, the number and proportion were reported stratified by prior military service status.

An unadjusted log binomial regression model was performed by regressing the prevalence of metabolic syndrome on prior military history. Furthermore, six different unadjusted log binomial regression models were performed by regressing the prevalence of each component of metabolic syndrome on prior military history. In addition, the seven log binomial regression models just described were performed