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Original article

Prospective Analysis of Health and Mortality Risk in Veteran and Non-Veteran Participants in the Women's Health Initiative

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A B S T R A C T

Background: The health of postmenopausal women veterans is a neglected area of study. A stronger empirical evidence base is needed, and would inform the provision of health care for the nearly 1 million U.S. women veterans currently 50 years of age or older. To this end, the present work compares salient health outcomes and risk of all-cause mortality among veteran and non-veteran participants of the Women's Health Initiative (WHI).
Methods: This study features prospective analysis of long-term health outcomes and mortality risk (average follow-up, 8 years) among the 3,706 women veterans and 141,009 non-veterans who participated in the WHI Observational Study or Clinical Trials. Outcome measurements included confirmed incident cases of cardiovascular disease (CVD), cancer, diabetes, hip fractures, and all-cause mortality.
Results: We identified 17,968 cases of CVD, 19,152 cases of cancer, 18,718 cases of diabetes, 2,817 cases of hip fracture, and 13,747 deaths. In Cox regression models adjusted for age, sociodemographic variables, and health risk factors, veteran status was associated with significantly increased risk of all-cause mortality (hazard ratio [HR], 1.13; 95% CI, 1.03–1.23), but not with risk of CVD (HR, 1.00; 95% CI, 0.90–1.11), cancer (HR, 1.04; 95% CI, 0.95–1.14), hip fracture (HR, 1.16; 95% CI, 0.94–1.43), or diabetes (HR, 1.00; 95% CI, 0.89–1.1).
Conclusions: Women veterans' postmenopausal health, particularly risk for all-cause mortality, warrants further consideration. In particular, efforts to identify and address modifiable risk factors associated with all-cause mortality are needed.
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Over the past several decades, considerable empirical attention has been directed to the associations between military service, health, and mortality risk (Kang & Bullman, 1996; McLaughlin, Nielson, & Waller, 2008), with a steadily increasing focus on women (Cypel & Kang, 2008; Dalager, Kang, & Thomas, 1995; Kang et al., 2014; Thomas, Kang, & Dalager, 1991; Vajdic, Stavrou, Ward, Falster, & Pearson, 2014; Waller & McGuire, 2011; Yi, 2013), whose representation in the armed forces has grown dramatically over this time period (U.S. Department of Veterans Affairs, 2011). Although this literature provides a strong foundation, it is limited in size and scope, with a predominant focus on women veterans during their early or midlife years (cf. Dalager et al., 1995). Given that there are nearly 1 million women veterans who are 50 years of age or older, increased research attention to health and mortality risk in women veterans' postmenopausal years is warranted.

Prior population-based studies have consistently documented decreased risk of morbidity and all-cause mortality among veterans, including women, relative to the general population (Cypel & Kang, 2008; Dalager et al., 1995; Kang et al., 2014; Thomas et al., 1991; Vajdic et al., 2014; Waller & McGuire, 2011; Yi, 2013). This "healthy soldier effect," typically documented in young to middle-aged veterans, is commonly ascribed to the health and fitness standards associated with military selection, as well as the increased commitment to physical fitness among military populations, and the continuous access to health care that military and veteran populations enjoy (see Kang & Bullman, 1996; McLaughlin et al., 2008). A very limited literature examining health and mortality risk in older veterans suggests that the "healthy soldier effect" attenuates with time (Liu, Engle, Kang, & Cowan, 2005; London & Wilmoth, 2010; Wilmoth, London, & Parker, 2010). Some research, in fact, characterizes a health "cross-over" effect among older veterans (i.e., age $\geq$70) who, despite many years of good health, evidence greater mortality risk and accelerated health decline, relative to non-veterans (Liu et al., 2005; London & Wilmoth, 2010).

This health "cross-over" is thought to reflect the latent, cumulative, or synergistic effects of military health risks, high prevalence health risk behaviors (e.g., smoking), and the long-term health consequences of military-specific exposures (e.g., trauma from warzone deployment, military sexual trauma, combat; London & Wilmoth, 2010). Moreover, it provides a useful framework with which to conceptualize the possibility of a more distal association between military service—which typically concludes in early adulthood—and health in older adulthood (London & Wilmoth, 2010). Although this paradoxical effect would be expected to generalize to women, research evaluating the healthy soldier effect among older women veteran populations is all but nonexistent.

Given the substantial (and growing) population of women veterans living in the U.S. today, research designed to characterize their postmenopausal health and mortality risks is warranted. The Clinical Trials and Observational Study of the Women's Health Initiative (WHI) program (The Women's Health Initiative Study Group, 1998) are well-positioned to address this literature gap. To this end, ours is the first study to evaluate whether women veteran participants in WHI (n = 3,706) have the same risk for key postmenopausal health conditions: cardiovascular disease (CVD), cancer, diabetes, hip fracture, and all-cause mortality, as the non-veteran participants (n = 141,009).

Materials and Methods

Overview of the WHI

The WHI includes a set of three National Institutes of Health (NIH)-sponsored clinical trials and an observational study designed to identify factors associated with the development of heart disease, cancer, and fracture in postmenopausal women (within WHI menopause was defined as no vaginal bleeding for 6 months if $\geq$55, 12 months for 50- to 54-year-olds, prior hysterectomy, or use of postmenopausal hormones) who were aged 50 to 79 at WHI baseline, between 1993 and 1998 (The Women's Health Initiative Study Group, 1998; a comprehensive list of the investigators associated with the implementation of the WHI are presented in the acknowledgement presented in Supplementary Appendix A).

Participants were recruited from 1993 to 1998 by 40 clinical centers around the country, which helped to ensure racial/ethnic, geographic, and sociodemographic diversity among the study participants. Original study endpoints for the observational study and clinical trials were in 2005. Extension studies are currently collecting follow-up data through 2015. The present work includes follow-up data through 2011, facilitating evaluation of long-term health outcomes over more than 20 consecutive years.

Institutional review boards at all participating clinical centers reviewed and approved study procedures. All participants provided written informed consent at baseline and again at enrollment in the extension studies. Detailed accounts of the WHI recruitment procedures, study design, and methodology have been previously published (Curb et al., 2003; Hays et al., 2003; The Women's Health Initiative Study Group, 1998).

WHI Data Collection and Adjudication Procedures

At baseline, participants completed self-report questionnaires designed to gather information related to WHI participants' sociodemographic, medical, and lifestyle characteristics. They also underwent a brief clinical examination that collected height, weight, and blood pressure measurements. WHI study follow-up involved completion of annual, mailed, follow-up questionnaires and regular physical examinations.

Health conditions identified through these methods were confirmed via local (physicians from the local/regional WHI Clinical Centers who review participants medical record and study related medical documents to assign a diagnosis) and central adjudication (i.e., physicians at the WHI Clinical Coordinating Center and the NIH review and confirm the diagnosis). To minimize the potential for bias, local and central physician adjudicators were restricted in their access to participants' research record such that they were not exposed to any information that could result in unblinding (see Curb et al., 2003).

Outcome Ascertainment

Morbidity-related outcomes, including incident CVD, malignant cancer, diabetes, and hip fracture were identified by patient self-report via annual study follow-up questionnaires or detected during regularly scheduled medical examinations that were incorporated into the WHI follow-up procedures. All morbidity outcomes were adjudicated centrally, with the exception of diabetes, which was confirmed, centrally, whenever possible.