

Veterans' Physical Health

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How individuals age is affected by life experiences. What we know today about aging has been largely shaped by a generation who experienced the special circumstances of wartime in their formative years. In this review, we investigate the research question, "What is known about the physical health of Canadian veterans?" In answering this question, we summarize the literature on Canadian Veterans but also include international literature on the physical health of American and Australian Veterans, along with some information from reports from Great Britain and other parts of Europe. Areas in which veterans perhaps fare worse than civilians of similar age include general health, hearing loss, musculoskeletal disorders, infections, cirrhosis, skin conditions, stomach conditions, neurologic conditions, and cardiovascular disease. The differing effects of combat on female veterans are also summarized. The healthy warrior effect is discussed along with its impact on research findings and the importance of choosing an appropriate control group.

aging; Canadian; female; general health; hearing loss; physical health; veterans

Abbreviations: ALS, amyotrophic lateral sclerosis; CI, confidence interval; OR, odds ratio; POW, prisoner of war; PTSD, posttraumatic stress disorder; RR, relative risk; VA, United States Veterans Health Administration; WWII, World War II.

Many from the generation of men over the age of 60 years lived in an era in which they and many of their peers (particularly in the United States) were eligible to be drafted as young men in their twenties (1). This is particularly true for nations that participated in the Vietnam War. It was estimated that in the United States in 1997, 75% of men who were over 65 years of age were veterans (1, 2). Some authors have suggested that some of the information gleaned from studies of older veterans may be generalizable to the larger group of all older men (2) and have called wartime experiences a "hidden" variable in their lives (3). It is unclear how much of what we know about aging is influenced by these experiences. Settersten calls for "future research [to] explore the many plausible direct and indirect connections between wartime experiences (especially combat) and psychological well-being, physical health, abilities and cognition, and marital and family functioning" (1, p. 27), and in this article, we explore the research question, "What is known about the physical health of Canadian

veterans?" In answering this question, we summarize the literature on Canadian veterans but also include the international literature on the physical health of American and Australian veterans, as well as some information from reports from Great Britain and other parts of Europe. This review was motivated by the involvement of 2 of the authors (P. R.; C. W.) with the Canadian Longitudinal Study on Aging (4), which includes questions that identify veterans. The focus of the review was on morbidities encountered by veterans 45–85 years of age, as this is the entry age level of participants into the Canadian Longitudinal Study on Aging. Thus, studies of veterans from the first and second Gulf Wars and Afghanistan are not considered here.

Much of what we know about veterans' physical health originates from work done in the United States, primarily conducted in Veterans Health Administration (VA) hospitals. Australian researchers have also been active in this field, and there have also been a few studies of British and

Dutch veterans. Many of these studies enrolled veterans of World War II (WWII) and the Korean War. Vietnam veterans have also been extensively studied, and although Canadian forces did not participate in this military effort, publications about Vietnam veterans were included, as they may contain information that is generalizable to all veterans. This literature is also pertinent because a significant number of Canadians served in the American armed forces at that time. (There are estimated to be 10,000–40,000 Canadians in this category (5).) Articles about peacekeepers were also included, as Canada has actively participated in many such missions; in fact, one Canadian source has estimated that Canada has contributed more peacekeepers to international efforts than has any other nation (6).

METHODS

This scoping review uses the methodological framework developed by Arksey and O'Malley (7). To identify potentially relevant studies, we conducted a literature search using several electronic bibliographic databases, including Google scholar, Copernic agent, Ovid Medline, PubMed (1964 to present), ISI Web of Science, EMBASE, PsychInfo, and the Cochrane Database of Systematic Reviews. Search terms varied by database but included “veteran or peacekeeper” and “health or general health or health status or epidemiology.” Because the focus of the present review was the physical sequelae we added “not post traumatic stress disorder (PTSD)” to our search strategy.

A study was included if it was carried out in veterans of any country (we focused on studies in which the age of participants was over 45 years), if it compared veteran subgroups with one another (e.g., prisoners of war (POWs) with other combat soldiers or deployed personnel with non-deployed military personnel), or if it compared veterans with the general population. Review articles were particularly useful, as they often contained information that was already categorized and summarized. The process of selecting relevant articles was an iterative one, with articles searched backwards and forwards to identify cited and citing references. The summarizing and reporting format chosen was a narrative one, as this was most in line with our objective of a broad description of the various ailments to which veterans are particularly prone and that may be a result of their combat experience.

International Studies of Veterans' Physical Health

Several large epidemiological studies have been undertaken. We begin by presenting a few details about each one.

The Centers for Disease Control and Prevention Vietnam Experience Study: Physical health status of Vietnam veterans, 1988. This study (8) was mandated by the United States Congress, and its aim was to describe the physical health of male veterans of the Vietnam War and to compare it with that of veterans from the same era who were not deployed to Vietnam. The study was carried out 15–20 years after these veterans participated in active service. Researchers randomly selected 7,924 Vietnam War veterans

and 7,364 non-Vietnam War veterans who had served in the US army from 1965 to 1971. All subjects participated in a telephone interview, and a random subsample (2,490 Vietnam War veterans and 1972 non-Vietnam War veterans) also underwent a comprehensive medical examination.

Morbidity of Vietnam veterans: A study of the health of Australia's Vietnam veteran community. Volume 1: Male Vietnam veterans survey and community comparison outcomes, 1998. This study (9) was completed for the Australian Department of Veterans' Affairs about Australia's Vietnam War veterans approximately 30 years after Australians were first deployed to Vietnam. A similar report was published about the morbidity of female Australian Vietnam War veterans. Researchers aimed to “compare the health and well being of Vietnam veterans, their spouses and their children, with Australians of comparable age in the general population, where comparative data exist” (9, executive summary). They accomplished this using a survey that was mailed to all surviving Australian Vietnam War veterans, of whom 80% (40,030) replied.

Health Study 2005: Australian Veterans of the Korean War. This study (10) was completed for the Australian Department of Veterans' Affairs and focused on the morbidity of Australian Korean War veterans. The aim of the study was “to compare Australia's surviving, male Korean War veterans with similarly aged Australian men, who resided in Australia at the time of the Korean War” (10, p. 11), and it included 7,525 Australian male Korean War veterans and compared them with 2,964 Australian men who were 65 years of age or older. The study was carried out just over 50 years after the end of the Korean War. All participants completed a self-report questionnaire about current quality of life and physical health and details about their Korean War experience, including severity and duration of combat exposure and war-related injuries.

Chronic morbidity of former prisoners of war and other Australian Veterans, 1991. Venn et al. (11) reviewed 48 studies and summarized the findings about long-term morbidity attributable to war-time experiences. They focused on Australian veterans, although some key British and American studies were included for comparison. Although they did not exclude studies about all veterans, they were particularly interested in POWs (over 35,000 Australians were captured during WWII in the Far East (11), where the conditions were more brutal than those experienced by POWs in Europe). Veterans of WWII, the Korean War, and the Vietnam War were included in that review.

Methodological considerations

In all of these studies, slightly different methods were used to carry out the research. Most studies were conducted by academic and/or hospital-based researchers, but one was conducted by a market research company. Several were commissioned by governmental agencies. Some asked just a few questions of many people, whereas others conducted detailed clinical and questionnaire-based examinations. Although an in-depth discussion of these differences and their consequences is beyond the scope of this article, it must be noted that these methodological variations make

comparisons between studies challenging. These differences may, at least in part, explain the variability of the results found and explored below.

In fact, even the definition of the word veteran is not consistent across countries. In the United States, a veteran is anyone who has served in the armed forces, irrespective of whether she or he was deployed outside the country, whereas in Australia, veteran status is only conferred on persons who served in a war or conflict zone. In Canada, the definition is closer to the American one, with a veteran being defined as a former officer or no-commissioned member of the Canadian Forces (regular or reserve).

Overall health

Several studies have reported on the general health of Vietnam War veterans, 2 of these from Australia and 1 from the United States. The first to be completed was the Centers for Disease Control and Prevention study of the health status of these veterans described above (8). The authors concluded that although Vietnam War veterans reported more health conditions than did nonveterans, at least in the sample ($n = 2,490$ veterans and 1972 nonveterans) who underwent a comprehensive medical examination, there were few objective differences between veterans' health and that of nonveterans (8).

In the Australian Vietnam Veterans Study, the authors similarly found that on self-report, veterans rated their health as poorer than would be expected from the general Australian population (9). In their 2009 report of a longitudinal Australian Vietnam Veterans Study, O'Toole et al. also found that on self-report, the general health of Vietnam War veterans was not as good as expected. In fact, they reported that the prevalences of 47 out of 67 long-term conditions about which participants were asked were higher than population expectations; just 4 were lower, including prostate cancer and type 2 diabetes mellitus (12).

Australian Korean War veterans also report poorer (lower) quality-of-life scores (10). The authors of that report considered the differences large enough to reflect important and meaningful differences between veterans and the general Australian population of similar age.

Hearing loss

The most commonly reported sequela of military service is hearing loss (13). Many of the tasks required of military personnel, both in training and combat, involve high levels of noise from machinery, explosives, jet engines, and firearms. A recent study found that severe hearing impairment was 30% more likely in veterans than in nonveterans after adjustment for age and current occupation (13). In veterans over the age of 65 years, 17% reported severe hearing loss compared with 10% of nonveterans. Surprisingly, these same authors reported an even greater prevalence of severe hearing loss in those veterans who had served more recently (i.e., in the 21st century) compared with nonveterans (14).

Evidence of hearing loss as a result of combat is not new. In 1991, Venn et al. (11) concluded that having a hearing deficit was one of 5 conditions that could be

attributed to war-time exposures. Also in 1991, Eisen et al. (15) confirmed an increased prevalence (odds ratio (OR) = 1.9, 95% confidence interval (CI): 1.3, 2.7) of current hearing problems in veterans who served in Southeast Asia during the Vietnam War. They evaluated a group of male monozygotic twins, one of whom had served in Southeast Asia and the other who had not. Hearing deficits have also been reported in Australian veterans of the Korean and Vietnam Wars (9, 10, 16). The authors of the health of Australia's Vietnam War veteran community study commented, "this is not an unexpected finding, as veteran populations have traditionally suffered higher levels of hearing difficulty" (9, Findings part A). In the Centers for Disease Control and Prevention study of American Vietnam War veterans, the authors found that the Vietnam War veterans had more prevalent hearing loss than did their non-Vietnam War veteran counterparts (8). Perhaps this reflects the trend reported by Groenewold and Masterson (13) of greater hearing loss in veterans of more recent combat arenas.

Musculoskeletal disorders

Military labor is physically demanding, and thus it may not be surprising that the Australian Vietnam War veterans study reported a high prevalence of musculoskeletal problems, particularly back problems (9). O'Toole et al., who also studied Australian Vietnam War veterans compared with the general Australian population, found significantly more arthritis (relative risk (RR) = 2.24, 95% CI: 1.43, 3.04), back disorders (RR = 2.07, 95% CI: 1.49, 2.66), and other musculoskeletal disorders (RR = 1.69, 95% CI: 1.20, 2.18) in veterans (16). The authors of one of the POW studies that we reviewed postulated that musculoskeletal disorders are worse in POWs because of malnutrition, beatings, torture, heavy labor, and/or combat injury (11). Australian veterans of the Korean War were found to experience significantly more self-reported arthritis (10). Keehn also studied American POWs from both WWII and the Korean War who were served by VA hospitals and found that 30 and 22 years after these conflicts, respectively, there was no evidence of increased mortality from chronic or degenerative diseases (17). It is likely that although musculoskeletal disorders cause suffering in aging veterans, they do not cause death (at least not death that is attributed to them on death certificates).

Infection

Several of the major combat arenas in the 20th century were in tropical areas in which many infectious agents are endemic (e.g., the Pacific arena in WWII, the Korea War, and the Vietnam War). Thus, it is not unexpected that veterans returned to their home countries harboring infectious agents. This would be especially true for prisoners taken in these areas, some of whom lived for years in circumstances of squalor and malnutrition (18), conditions that are conducive to the transmission of these pathogens. Beebe documented that WWII POWs captured in Japan and Korea

suffered far more from tuberculosis, other infectious, and parasitic diseases than did POWs captured in Europe (18).

Keehn noted an increase in mortality from tuberculosis and other infectious and parasitic agents in returned POWs (WWII and Korean War) for many years after their return to the United States (17). The Australian Korean War Veteran study reported that approximately 13% of surviving veterans reported malaria that they had been told was a result of their Korean deployment (10). A small number of these veterans also reported haemorrhagic fever. The Australian Vietnam War veterans study found a high prevalence (8%) of malaria in the group that they studied (9). Venn et al. found an increased prevalence of hepatitis (both A and B) among former POWs in Australia many years after their return home; non-POW veterans also had an elevated prevalence of these infections (11). Similarly, O'Toole et al. report an increase of infective and parasitic agents among veterans, with increased combat exposure being related to an increased prevalence (16). Page and Miller report on 2 earlier studies of WWII British and Australian POWs from the 1980s, both of which found evidence of high prevalence of hepatitis (19). In their own study, Page and Miller also found high rates of hepatitis and helminthiasis (infection by parasitic worms) in a group of former American POWs from WWII and the Korean War (19). In 2005, Mathes et al. published a follow-up on the long-term sequelae of hemorrhagic fever with renal syndrome attributable to Hantaan virus in a group of Korean veterans who were seen at VA hospitals (20).

Among parasitic agents causing infection, the most common in veterans appears to be the roundworm (nematode) *Strongyloides stercoralis*, which causes strongyloidiasis (9, 11). The infestation may lie dormant for decades and only become active later in life, often when the individual is treated with corticosteroids. Alternately, these worms may burrow into the skin, causing urticarial rashes (itchy red bumps), or into the lining of the digestive tract, causing diarrhea and abdominal pain. There it may become chronic.

Cirrhosis

Several authors have investigated the longer-term consequences of infections, particularly rates of cirrhosis as a result of chronic hepatitis. In 1980, Keehn reported excess mortality due to cirrhosis, which began to be apparent from approximately the 10th year of follow-up among American WWII and Korean War POWs (17). Page and Miller returned to the same cohort and in 2000 again reported excess mortality due to cirrhosis 50 years after the end of WWII, although the rate had begun to wane somewhat after 30 years. They report a 32% higher mortality rate among WWII POWs compared with the US general population (19). These authors suggested that increased alcohol consumption did not explain the excess mortality and found evidence of increased rates of both hepatitis and helminthiasis. Gale et al. (21) studied a group of British POWs who were held by the Japanese during WWII and also reported excess mortality from liver disease (cirrhosis and hepatic carcinoma). These authors also speculated that some individuals may have been infected with hepatitis C, although

this was not documented. They commented that "communal use of poorly sterilised needles and surgical instruments, the transfusion of blood taken from other prisoners, and beatings with the same weapon would have facilitated the transmission of this blood-borne virus" (21, p. 2118). Australian researchers also found significantly more self-reported liver disease among their Korean War veterans (10).

Australian investigators studying Vietnam War veterans have also found some excess cirrhosis compared with the Australian general population (9). However, they attributed this to alcohol-related problems. Venn et al. found reports of serologic evidence of prior infection with hepatitis B in the veterans studied, but they did not find an excess of cirrhosis (11). They speculated that in this population, those who succumbed to the disease did so early in life, as evidenced by increased mortality rates due to cirrhosis in the first 10 years after the war. Those who survived past that time appeared to have been able to clear the virus and are now free of significant liver disease. In their review of the literature, they also did not find evidence of increased rates of hepatic cancer. They wondered if perhaps enough time had not elapsed (18–40 years in the cited studies) for the disease to develop (11).

Thus, there is some discordance between the studies of earlier conflicts as compared with the Vietnam War in regards to long-term liver disease. It is possible that there was something different about these various arenas of war and the rates of hepatitis infection. Alternately, these results may be confounded by heavy alcohol intake among some veterans, which perhaps occurred and continues to occur at differing rates among different groups of veterans.

Skin conditions

Persistent skin conditions have been reported by authors studying both Australian and American veterans. O'Toole et al. found an excess of rashes, eczema, and other skin conditions in the group of Australian Vietnam veterans that they studied as compared with the general Australian population (16). Similarly, the Australian study of the health of Vietnam War veterans reported a much higher prevalence (45%) of dermatitis/eczema than seen in nonveteran cohorts. In fact, the authors commented that "skin conditions have been a persistent cause of complaint by Vietnam veterans" (9). They also found rashes attributable to infection with strongyloidiasis in Vietnam War veterans as was reported above for WWII POWs (19). Eisen et al. have also reported an increase of both current persistent skin conditions (OR = 2.1, 95% CI: 1.4, 3.2) and ever having had a persistent skin condition (OR = 2.1, 95% CI: 1.5, 3.0) in their study of American twins.

All of the reports of skin conditions not related to persistent helminthiasis or fungal infections come from studies of Vietnam War veterans. The suggestion has been made that this may be a manifestation of psychological conditions arising from combat exposure (16).

Stomach conditions

In 1991, Venn et al. published a review article of long-term morbidity associated with war service and found that

peptic ulcers are associated with combat in Australian veterans (11). Eisen et al., who studied American twins from the Vietnam era, likewise found that there was: 1) a greater likelihood for the twin who saw combat service to have been hospitalized for a stomach condition (OR = 2.6, 95% CI: 1.4, 4.9) and 2) a marginally increased odds ratio for ever having stomach conditions (OR = 1.4, 95% CI: 1.0, 1.9) (15). Similarly, both the Korean War Australian veterans morbidity study (10) and the Australian Vietnam veterans health study (9) found an increase in the self-reported prevalence of ulcers (both stomach and duodenal in the Korean War veterans) as compared with the general Australian population. Thus, all groups that investigated this condition found that an increase in stomach conditions, in particular ulcers, appeared to be related to combat.

Neurologic conditions

To date, few studies have investigated the prevalence of neurologic conditions in veterans. In 1980, the suggestion was made that the malnourishment experienced by British POWs in the Far East that resulted in short-term neurologic conditions (mostly optic atrophy and peripheral neuropathies) might also have had some long-term neurologic consequences (22). In particular, something about the severe conditions experienced by these POWs (perhaps the malnourishment) might have caused an excess of Parkinson's disease in these men. In contrast, upon review of the records of 11,915 British men who were former POWs in the Far East, Gale et al. showed that not only were overall mortality rates lower than expected, the rate of mortality from Parkinson's disease was also lower than that in the general British population (21). They also documented lower rates of motor-neuron disease, multiple sclerosis, and dementia (21). Page and Tanner (23) replied in a letter to the editor with mortality data from American POWs, which suggest that American Pacific POWs had twice the death rate from Parkinson's disease as that shown by non-POW veterans. Their study was smaller, enrolled slightly younger veterans, and compared POWs with other veterans. These differences may explain the inconsistent results. The Australian Vietnam veterans study showed a higher than expected rate of multiple sclerosis (9), which is also different than the results obtained by Gale et al.

Weisskopf et al. cited several publications that suggested that amyotrophic lateral sclerosis (ALS) is increased in Gulf War veterans from the United States (24). Their own study investigated the death rate from ALS using a large database from the Cancer Prevention Study II cohort and found that men who had served in the military had an increased death rate from ALS (RR = 1.53, 95% CI: 1.1, 2.1) compared with those who had not served. This result held for every birth cohort from 1915 to 1939. This evidence was included in a review of the potential relationship between military service and development of ALS that was commissioned by the US Department of Veterans Affairs from the Institute of Medicine of the National Academies. The report was published in 2006 included no evidence from Gulf War veterans and concluded that "[o]n the basis of its evaluation of the literature, the committee concludes

that there is limited and suggestive evidence of an association between military service and later development of ALS" (25, p. 3).

Krishnan et al. studied more than 2 million male veterans over the age of 65 years who were registered nationwide in VA hospitals to investigate incidence of dementia (26). The population studied was mainly white and almost exclusively male, and the authors found a prevalence of 7.3%, which is comparable to that rate found in other studies for white males. Qureshi et al. (27) found a 2-fold increase in 11-year period prevalence among those veterans with PTSD even after adjustment for confounding illnesses, combat-related trauma, and number of primary care and mental health visits and a 9-year incidence rate of 9.3% in those with PTSD versus 4.4% in those without PTSD. The authors wondered if cognitive impairment in PTSD is an early marker of dementia, if PTSD is an independent risk factor for dementia, or if PTSD and dementia share common risk factors, such as low cognitive reserves. It seems clear that PTSD is associated in some way with increased rates of dementia, but the nature of the association remains to be elucidated. Overall, there have been suggestions of associations between combat service and selected neurologic conditions, but more work remains to be done to confirm or refute these varied results.

Cardiovascular disease

In the mid-1970's there began to be suspicion in the United States of an increase in ischemic heart disease-related deaths in those soldiers who had leg amputations during World War II (28). About this time, Beebe reported that hospital admission rates for cardiovascular diseases were higher among some POW groups than among non-POW veterans and that arteriosclerotic heart disease was the major contributor to this excess (18). A study carried out by the Medical Followup Agency of the National Academy of Sciences using a large VA database confirmed that persons who had undergone bilateral above-knee amputations had a mortality rate from ischemic heart disease that was 3.5 times higher than that of a comparable group of VA-treated veterans (men with disfiguring scars but no amputation) (28). It was postulated that the large weight gain seen in the amputee veterans because of forced physical inactivity was a factor. To investigate this further, Rose et al. carried out an in-depth cardiovascular workup of 19 Vietnam veterans who had undergone bilateral above-knee amputations and 12 who had undergone unilateral below-elbow amputations (28). They did not find evidence of either clinical or subclinical ischemic heart disease in either group (aged 31–44), although they did find that a high number (29%) of bilateral above knee amputees veterans were both obese and hypertensive. It is possible that this group was not yet old enough to show detectable signs of ischemic heart disease. Similarly, O'Toole et al. found that cardiovascular morbidity was one of 6 categories (out of 37 chronic conditions asked about) where Australian veterans did not report a higher than expected rate of disease (16).

In the study of the health of Australia's Vietnam veterans, however, it was found that veterans had a much higher

than expected rate of ischemic heart disease (9). It had previously been shown that Australian Vietnam veterans had a 10% greater than expected mortality rate attributable to heart disease (9). Similarly, in the Korean War Australian veterans study, veterans self-reported currently suffering from a significantly higher rate of heart attacks and angina than the Australian general population (10).

Thus, the link between combat and cardiovascular disease is not certain. It is possible that in some subgroups of veterans, this is mediated by other risk factors such as obesity or hypertension that was seen in the bilateral above knee amputees. It is also possible that something about the brutal conditions (perhaps as a result of starvation) survived by the Far East POWs puts them at greater risk for cardiovascular disease.

Female veterans

There is little published research focusing on the health outcomes in female veterans. Bond, who provided a good history of women in American military service, commented in 2004 that there were many mortality studies on women in the Armed Forces but decried the lack of investigations into morbidity (29).

Seventy-nine American women who each had suffered 3.5 years of incarceration as POWs at the hands of the Japanese during WWII were studied in 1995 by Skelton and Skelton (30). About half of them reported a service-connected disability, which is about the same proportion for American male POWs. In the male POWs, there was excess mortality due to tuberculosis in the early years after the war and in addition, many men reported disability related to peptic ulcer. In contrast, in the study by Skelton and Skelton, none of the women died of tuberculosis or were compensated for a stomach condition. The reasons for these discrepancies remain unclear.

In 2011, Bean-Mayberry et al. published a systematic review on the health of female veterans (31) that updated their previous work (32). During the 5-year update period, they identified 195 new publications, or approximately the same number as in the previous 25 years ($n = 182$). This increase in interest likely reflects the increasing number of women being recruited into the military (31). In 2006, 20% of new American military recruits were women. Many of the newer publications focus on results of the more recent combat arenas, in particular the Persian Gulf War, and these are not reviewed here.

Most often, when physical health is discussed in reports of the health of female veterans, it is as a result of PTSD, and in fact Schnurr and Green have posited that poor physical health outcomes may be a major pathway through which trauma exposure affects health (33). In their study of 266 female veterans at Puget Sound VA medical center who screened positive for PTSD, Dobie et al. found these women more likely to report problems with obesity, smoking, irritable bowel syndrome, fibromyalgia, chronic pelvic pain, polycystic ovary disease, asthma, cervical cancer, and stroke than those without PTSD (34). A complicating factor was that many of these women were

sexually assaulted while in war zones (32), suffering physical injury as well as psychological sequelae.

One notable exception to the predominant focus on PTSD and younger veterans is the Australian female Vietnam War veterans survey (35). Although the authors tried to contact all 484 female veterans of this conflict, only 278 were located and only 223 responded. As in their male counterparts, female Vietnam veterans self reported an excess of many physical conditions. Although women rated their general health lower than comparable Australian women, they were more positive in the perception of their current health than male veterans. Female veterans were twice as likely to report their health as excellent or very good. The physical conditions that showed a statistically significant excess above that in the general Australian population included hearing loss, malaria, hepatitis (both A and B), eczema/dermatitis, gastric reflux, ischemic heart disease, and any cancer (35). These women also reported more breast cancer, more stillbirths, and more live births with labor complications. The prevalence of hepatitis was higher than that reported by their male counterparts, but females reported malaria less frequently than did male Vietnam War veterans. Prevalence of complete or partial deafness (18%) in female veterans, although significantly higher than in Australian women of a comparable age, was found to be much lower than reported by male veterans (55%) (35). Groenwold and Masterson similarly found that American female veterans had a significantly lower prevalence of severe hearing loss as compared with male veterans (4.0% versus 10.9%; $P = 0.05$) but a significantly higher prevalence than either male or female nonveterans (13).

There are many possible explanations for these differences. For example, women may have been exposed to different military experiences than men were, particularly in WWII, the Korean War, and the Vietnam War, when women in combat were often health care workers, especially nurses (29). In addition, some diseases manifest differently in men and women, with the prevalence of some diseases being quite different between the sexes. There are also some sex-specific issues that are manifest during combat service, such as sexual harassment and assault. For these reasons, female veterans may have different health care needs than do male veterans.

CANADIAN STUDIES OF VETERANS' PHYSICAL HEALTH

In March 2009, there were 219,150 persons registered with Veterans Affairs Canada (36). The vast majority of Canadian war veterans and their surviving spouses are currently in their 80s and 90s. They are coping with increasingly serious health issues. The number of war-service clients will decline as these older veterans die, and the characteristics of those seeking help from Veterans Affairs Canada will change. These will be mainly peacekeepers, their family members, and Royal Canadian Mounted Police injured in the line of duty. In the United States, it is estimated that about 20% of new recruits to the armed forces are women (32), and it is likely that there is a comparable rate in Canada. Compared with information from the United

States and Australia, there is a dearth of information about the physical health of Canadian veterans, although interest in this area is not new. As is the case in the international literature, published studies concerning the health of Canadian veterans examine, in one way or another, the psychological sequelae of combat and particularly PTSD and its correlates.

As with international troops, Canadian veterans brought home infectious diseases. In 1953, Hale and Halpenny reported on 152 veterans with malaria who were treated in Montreal (37). While these soldiers were in Korea, they were on suppressive therapy and so it was not until they returned home and stopped the medication that cases began to appear in Canada. There was an annual incidence rate of 11% in returning veterans to the Montreal area in 1952. At the time of publication, mortality and full relapse data were unavailable. Other infectious diseases were also prevalent, as evidenced by higher-than-population rates of tuberculosis in veterans (from The Canadian Pensions commission in 1965 and cited by Tennant et al. (38)). There was no information on the rates of hepatitis in these returning veterans.

In their 1986 article, Tennant et al. referred to a 1965 report by Richardson to the Canadian Pensions Commission titled, "Disabilities and problems of Hong Kong veterans, 1964–1965" (38). This document, now out of print, reported higher mortality rates in Canadian veterans compared with population rates from accidents, cardiovascular disease, and tuberculosis.

Although we found no assessments of hearing loss in Canadian veterans, a study was recently conducted into the risk factors for the development of noise-induced hearing loss in active Canadian forces personnel (39). The author stated that claims to Veterans Affairs Canada for noise-induced hearing loss in the Canadian forces were \$33 million annually (2000–2001 data).

In their PTSD research, Richardson et al. studied a group of 707 Canadian peacekeeping veterans who were deployed between 1990 and 1999 and had both PTSD and other health problems. They found an increase in gastrointestinal disorders (stomach and/or intestinal ulcers), musculoskeletal problems (arthritis, rheumatism, and/or back problems), and headaches (migraines), but not cardiovascular illness (high blood pressure and/or heart problems) (40). Although they included females in the study, there were too few ($n = 30$) to allow for meaningful subgroup analyses. These results may not be generalizable to the larger group of all veterans, because only veterans with PTSD were included.

Recently, Speechley et al. investigated the occurrence of falls in a group of older (average age 80 years), community-dwelling veterans in Ontario (41). They found that 40% reported having fallen in the last year, but just 30% of their caregivers reported falling in the last year. Other prospective studies of community dwelling seniors over 75 years of age reported an annual fall rate of about 33% (41). Speechley et al. thus concluded that Canadian veterans of World War II and the Korean War are frailer and at a slightly higher risk of falling than are their caregivers and are also frailer than previously studied populations of older community-dwelling persons. It is unfortunate that they used as the comparison group the veterans' caregivers who

were usually female and on average about 3 years younger; perhaps an age-matched cohort of community-dwelling men might have been more informative. They identified financial strain as a risk factor for falling. They did not ask about the veterans' war experiences and did not attempt to verify whether some of the vision and balance problems also reported by these veterans could be related to their combat exposure many years ago.

Only one of the studies retrieved discussed Canadian POWs from WWII or the Korean War. This study was published in 1947 and discussed some of the nutritional disturbances of POWs held by the Japanese (42). Long-term sequelae were not explored. We did not find any reports about the health of Canada's female veterans.

HEALTHY WARRIOR EFFECT

Studies of veterans are susceptible to 2 types of biases (1). The first is that there is an important selection process to be admitted to the military. One must be assessed as strong and physically, mentally, and socially healthy. The potential for survivor bias is created when these healthy individuals encounter combat and the weakest of them and the most severely injured die. Thus, veterans available for study many years after the war's end may be healthier than civilian populations of a similar age (1). This is called the healthy warrior effect and is analogous to the healthy worker effect seen in populations of working people. Some authors have estimated that mortality rates may be 10% to 25% lower compared with the general population and depending on the cause of death under investigation (43). This effect has been shown in female veterans as well (44). Seltzer and Jablon have shown that this effect persists for at least 23 years, depending on the cause of death (45). This healthy warrior effect may conceal some mortality and morbidity that should be attributed to combat exposure. One way to address this form of bias is through a judicious choice of comparison group. Many studies use as a control group veterans who are similar in as many respects as possible with the exception of the variable of interest (e.g., combat) rather than general population comparison groups.

DISCUSSION

Spiro et al. have called military service a hidden variable in aging studies (46). Many older men have participated in military activities and have suffered (and perhaps still suffer) from their experiences during that time. Yet, often these early traumatic experiences are not discussed even in a health care situation. For the most part, veterans remain silent about these early events, sometimes only marginally coping with their memories (47). Some of the consequences of trauma situations may be exacerbated by facets of normal aging, such as diminishing physical capacity, loss of friends and loved ones, and perhaps loss of self-image at retirement (47).

How individuals age is affected by the experiences they have lived. What we know today about aging has been largely shaped by a generation who experienced the special circumstances of wartime in their formative years, and yet

these experiences have often not been considered in aging research.

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