

Riitta Leskinen

LATE-LIFE FUNCTIONAL
CAPACITY AND HEALTH
AMONG FINNISH WAR
VETERANS

VETERAN PROJECT 1992 AND 2004 SURVEYS

UNIVERSITY OF OULU GRADUATE SCHOOL;
UNIVERSITY OF OULU
FACULTY OF MEDICINE;
MEDICAL RESEARCH CENTER OULU;
OULU UNIVERSITY HOSPITAL;
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**LATE-LIFE FUNCTIONAL CAPACITY
AND HEALTH AMONG FINNISH
WAR VETERANS**

Veteran Project 1992 and 2004 surveys

Academic dissertation to be presented with the assent of the Doctoral Training Committee of Health and Biosciences of the University of Oulu for public defence in Auditorium F202 of the Faculty of Medicine (Aapistie 5 B), on 26 September 2015, at 12 noon

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Abstract

Becoming involved in war is an experience that has the potential to shape later-life health. The aim of the present study was to explore Finnish Second World War veterans' health status and the determinants of self-rated health (SRH) and functional capacity, especially the ability to walk, and to identify risk factors and their combinations that predict late-life mortality among veterans.

The study population comprised Finnish Second World War veterans who participated in the Veteran 1992 and Veteran 2004 Project surveys. In 1992, a postal questionnaire was sent to all 242,720 war veterans living in Finland. The follow-up survey, the Veteran 2004 Project, was conducted with a randomized sample of veterans who participated in the Veteran 1992 Project. The total number of participants in the baseline survey was 177,989 men and 48,745 women, and in the follow-up survey, 4,348 men and 651 women. The response rate was high in both surveys: 93% in 1992 and 87% in 2004. All analyses were conducted separately for men without disability, men with disability and women.

In a cross-sectional study, SRH and functional capacity was found to be better among 80–84-year-old Finnish war veterans in 2004 compared with 1992, although the prevalence of many diseases increased during the follow-up.

Among the 4,999 veterans who participated in both surveys, the majority rated their health as improved or unchanged during the follow-up. Walking difficulties and cardiovascular (CVD), musculoskeletal and neurological diseases were found to be predictors of declined SRH. When exploring functional capacity among veterans, neurological and musculoskeletal diseases, but especially walking difficulties, predicted veterans' future functional impairment as many as 12 years in advance, and worsening of these conditions was associated with impaired activities of daily living.

During an average 9.9-year follow-up, walking difficulties alone or together with multimorbidity and/or with a third risk factor was the most important risk factor for total and for CVD mortality among all veteran groups.

In conclusion, the majority of veterans rated their SRH as improved or unchanged during the follow-up. The importance of walking difficulties as a determinant of SRH and functional capacity and as a predictor of mortality was confirmed.

Keywords: Finland, functional capacity, late-life mortality, self-rated health, trends in health, walking difficulties, war veterans

Leskinen, Riitta, Sotiemme veteraanien terveys ja toimintakyky. Veteraaniprojekti 1992 ja 2004

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Tiivistelmä

Tutkimuksen tarkoituksena oli arvioida suomalaisten toisen maailmansodan veteraanien terveydentilaa ja tutkia, mitkä tekijät vaikuttavat veteraanien itsearvioituun terveyteen ja toimintakykyyn (erityisesti kävelykykyyn) sekä tunnistaa ne riskitekijät ja tekijäyhdistelmät, jotka ennustavat kuolleisuutta.

Tutkimuspopulaationa käytettiin Veteraaniprojekti 1992 ja Veteraaniprojekti 2004 -tutkimuksiin osallistuneita veteraaneja. Vuonna 1992 kysely lähetettiin postitse jokaiselle Suomessa tuolloin asuneelle 242 720 veteraanille. Seurantatutkimukseen valittiin 5 750 veteraanin satunnaisotos vuoden 1992 tutkimukseen osallistuneista. Veteraaniprojekti 1992 -tutkimukseen osallistui 177 989 miestä ja 48 745 naista ja seurantatutkimukseen 4 348 miestä ja 651 naista. Osallistumisprosentti oli 93 % (1992) ja 87 % (2004). Analyysit tehtiin erikseen veteraanimiehille joilla ei ollut invaliditeettia, invalidimiehille ja naisille.

Poikkileikkaustutkimuksessa tarkasteltiin 80–84-vuotiaiden veteraanien terveyttä ja toimintakykyä vuosina 1992 ja 2004. Vuonna 2004 veteraanit arvioivat terveytensä ja toimintakykynsä paremmiksi kuin samanikäiset veteraanit vuonna 1992, vaikka monet sairaudet yleistyivät seuranta-aikana.

Suurin osa molempiin kyselyihin vastanneista 4 999 veteraanista arvioi terveytensä joko parantuneen tai pysyneen ennallaan seuranta-aikana. Veteraanien kokemat kävelyvaikeudet, sydän- ja verisuonisairaudet, tuki- ja liikuntaelinsairaudet sekä neurologiset sairaudet ennustivat itsearvioitun terveyden heikkenemistä. Sydän- ja verisuonisairauksia lukuun ottamatta edellä mainitut tekijät ennustivat myös toimintakyvyn laskua jopa 12 vuotta etukäteen. Myös kävelykyvyn heikkeneminen ja sairauksien paheneminen seuranta-aikana ennustivat toimintakyvyn laskua.

Kävelyvaikeudet joko yksin tai yhdessä multimorbidityn ja/tai jonkin kolmannen riskitekijän kanssa oli tärkein sekä kokonaiskuolleisuutta että sydän- ja verisuonitautikuolleisuutta ennustava tekijä kaikissa veteraaniryhmissä keskimäärin 9,9 vuoden seuranta-aikana.

Yhteenvedon voidaan todeta, että enemmistö tutkimukseen osallistuneista veteraaneista arvioi terveytensä joko parantuneen tai pysyneen ennallaan seuranta-aikana. Koetut kävelyvaikeudet ovat erittäin tärkeä itsearvioitua terveyttä, toimintakykyä ja kuolleisuutta ennustava tekijä.

Asiasanat: itsearvioitu terveys, kuolleisuus, kävelyvaikeudet, sotaveteraanit, Suomi, terveyden trendit, toimintakyky

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Oulu, June 2015

Riitta Leskinen

Abbreviations

AADL	Advanced activities of daily living
AAV	Accidents and violence
ADL	Activities of daily living
BADL	Basic activities of daily living
CI	Confidence interval
CHD	Coronary heart disease
CVD	Cardiovascular disease
HALE	Healthy life expectancy
HR	Hazard ratio
IADL	Instrumental activities of daily living
ICF	International Classification of Functioning, Disability and Health
km	kilometer
m	meter
OR	Odds ratio
PTSD	Post-traumatic stress disorder
SRH	Self-rated health
The U.S.	The United States
WHO	World Health Organization

List of original publications

This thesis is based on the following articles, which are referred to in the text by their Roman numerals:

- I Leskinen MR, Laatikainen TK, Tuomilehto JO, Nissinen MA, Peltonen M, Koistinen PO, Antikainen RL (2010) Trends in health status and the use of services among the 80–84-year-old Finnish war veterans during 1992 and 2004. *Scand J Public Health* 38(4): 434–441.
- II Leskinen R, Antikainen R, Peltonen M, Sippola R, Jousilahti P, Laatikainen T (2012) Determinants of changes in self-rated health among Finnish war veterans: results from the Veteran Project 1992 and 2004 surveys. *Arch Gerontol Geriatr* 55(2): 343–348.
- III Leskinen R, Laatikainen T, Peltonen M, Levälähti E, Antikainen R (2013) Prevalence, predictors and covariates of functional status impairment among Finnish Second World War veterans during 1992–2004. *Age Ageing* 42(4):508–514.
- IV Leskinen R, Laatikainen T, Peltonen M, Levälähti E, Antikainen R (2015) Self-reported Walking Difficulty Predicts Late-life Mortality among Finnish War Veterans. Results from the Veteran 1992 Project Survey. *J Am Geriatr Soc* 63(1):118–123.

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1 Introduction

In recent decades, life expectancy at age 65 has increased significantly among both men and women in all European Union member states (OECD 2012). In Finland, people aged 65 years and over accounted for 18.8% of the total population in 2012. According to predictions, the proportion of people aged 65 years and over will be 22.6% in 2020 and 25.6% in 2030 (Koskinen *et al.* 2014). The greatest major category in social protection expenditure is services and pensions related to old age, although the number of beds in nursing homes and in long-term care in health centers has been reduced since the beginning of the 2000s (Koskinen *et al.* 2014), and trends of function have improved in cross-sectional studies (Helldán & Helakorpi 2014).

In April 1992, the Council of State of Finland made a decision in principle to determine the Finnish Second World War veterans' state of health, living conditions and use of rehabilitation services. The baseline survey, the Veteran 1992 Project, was conducted with the entire cohort of Finnish war veterans living in Finland. A postal questionnaire was sent to 242,720 veterans (191,525 men and 51,195 women), with a mean age of 73.6 years. The original objective of this study was to reach those war veterans in need of medical treatment or who had remained outside the scope of services, as well as to improve the provision of services to veterans (Ryynanen *et al.* 1994). The follow-up survey in 2004, the Veteran 2004 Project, was conducted with a randomized sample of veterans who participated in the Veteran 1992 Project. The aim of this project was to investigate possible changes in the state of health and functional capacity and the use of rehabilitation and social and health care services among Finnish war veterans and to describe the effects of the measures which were made based on the results of the Veteran 1992 Project (Laatikainen *et al.* 2009). The National Institute for Health and Welfare (formerly the National Public Health Institute in Finland) conducted both surveys in cooperation with the Finnish regional and local authorities and the veterans' own organizations.

Functional status is one of the most important health measurements in the elderly. Its decline has been defined as having difficulties in the activities of daily living (ADL), such as difficulties in the basic activities of daily living (BADL), including appropriate upper and lower extremity function, and difficulties in the instrumental activities of daily living (IADL), including self-care and household chores (Stuck *et al.* 1999). The proportion of subjects with functional dependence in ADL increases with age (McGee *et al.* 1998), and associated chronic conditions

may lead to functional status decline (Guccione *et al.* 1994, Nikolova *et al.* 2011, Rozzini *et al.* 1997). Functional status decline in older adults may compromise living at home (Kozakai *et al.* 2013, Luppá *et al.* 2010) and lead to social isolation (Lund *et al.* 2010). Both ADL and mobility disability have also been shown to result in shorter life expectancy and longer time of survival period spent in disabled states (Keeler *et al.* 2010).

War experiences have been thought to have an impact on veterans' whole lifespan (Nivala & Sarvimäki 2015). It has been suggested that psychological or physical trauma and stress in young adulthood may have lifelong effects on veterans' health and lead to increased mortality in late adulthood (Bramsen *et al.* 2007, Elder *et al.* 1997, Kunnas *et al.* 2011, Page & Brass 2001). Functional status decline in older adults may be slowed down by external support and interventions (Chen *et al.* 2014a), and therefore it is essential to discover the risk factors leading to the development of disability. In our study, we focused on the Second World War veterans' self-reported physical and mental conditions and their ability to predict changes in veterans' self-rated health (SRH), functional capacity and mortality. As the ability to walk is important for independent living, we analyzed it separately. The study population of the present study is unique, because virtually the entire Finnish adult male population of the time participated in our study.

2 Review of the literature

Few studies have previously been conducted among Second World War veterans. The veterans in previous studies have generally been younger than the veterans in the present study and the studies have mostly focused on the veterans' quality of life and mental disorders. War veterans are part of the geriatric population, and thus they are likely included in studies concerning the elderly population in general. In Chapter 2.1, literature about Second World War veterans' health state and functional status is introduced, and after that literature concerning the determinants of self-rated health (SRH), functional capacity and mortality among the elderly in general is presented.

2.1 Second World War veterans' health state and functional status

Becoming involved in war is an experience that has the potential to shape later-life health, and even decades after the war ended, many veterans have problems relating to their war experiences. The impact of war on veterans' life has been shown to vary depending on individual characteristics, the timing of military service during the life course, service experiences, and historical periods (i.e. health trajectories vary depending on the war in which veterans served) (Wilmoth *et al.* 2010).

In the United States (the U.S.), Second World War, Korean and Vietnam War veterans have been shown to have better health than non-veterans around retirement age. This has been explained to result from the fact that service members were screened before entry to service (persons with poor health were excluded), and had better access to preventive health services and medical care during and after military service than most civilians (Wilmoth *et al.* 2010). However, veteran status has been found to have an impact on age-dependent transitions in functional status, and veterans seem to have poorer health compared with non-veterans among the oldest old (Liu *et al.* 2006).

A large number of veterans have experienced war-related psychological distress even 50 years after the event. Post-traumatic stress disorders (PTSD) in Second World War combat veterans has been found to present with physical, psychological, and social manifestations. Psychological distress experienced by veterans has been shown in part to be directly related to particular experiences, but intrusion and avoidance have both been found to play an important role as mediating variables (Hunt & Robbins 2001). A relatively low rate of PTSD

(<10%) has been reported among Finnish Second World War veterans (Hautamaki & Coleman 2001) compared with veterans from other countries. This has been thought to be due to the strong community spirit built up during and after the war and the continuing esteem of war veterans by Finnish society. However, physical health has been seen to have a more important effect on functional status changes in functionally dependent veterans than has mental health (Liu *et al.* 2006).

2.2 Self-rated health (SRH)

A person's own health perception, self-rated health (SRH), has been widely used as a measure of health status since the 1950s. It is based on asking individuals to evaluate their health status on a four- or five-point scale from excellent to poor (global SRH), or to compare their health status with that of their age peers, or their current health with their previous health (comparative SRH) (World Health Organization 1996). SRH is a more subjective health indicator than functional status and forms a continuum from excellent to poor health even if a wide range of self-reported and objectively measured indicators of health have been taken into account (Jylha 2009, Leinonen *et al.* 2002).

Consistent declines have been seen in the proportions of the older populations up to the oldest old rating their health as moderate or poor (Crimmins 2004, Zunzunegui *et al.* 2006). This has been thought to be due to reported declines in the prevalence of disability (Martin *et al.* 2007). In the U.S., adults 65 years old or older reported stable or improving SRH from 1993 to 2001, whereas during the same period, SRH worsened, especially among 45–54 years old adults (Zack *et al.* 2004). Among Finnish people aged 65–84 years, SRH has improved since the early 1990s, reflecting the improving health status of older people generally (Helldán & Helakorpi 2014). The health-related correlates of SRH in older men and women in three continents (in Australia, the U.S., Japan and South Korea) have been found to be similar, with those with more medical conditions, functional limitations or poor mental health giving poorer ratings (French *et al.* 2012a). However, when determining SRH, it is important to consider earlier life experiences as well as national and individual factors in later life.

2.2.1 Determinants of self-rated health

Sociodemographic factors

People with increasing age, particularly those over 80 years old, have been observed to rate their health better than that of their age peers. The association of older age with better comparative SRH has been found to become even stronger after adjustment for functional ability, chronic diseases and sociodemographic factors (Vuorisalmi *et al.* 2006). Global SRH does not decrease with advancing age to the same extent as chronic conditions and disability increase (Ishizaki *et al.* 2009, Jylha *et al.* 2001), but the relation of older age with global SRH has been shown to be weaker than that with age-referential SRH (Vuorisalmi *et al.* 2006). Adaptation to deteriorating health plays an important role in older people's health assessments: the majority tends to assess their health as similar to or even better than their peers with increasing age, despite an increase in chronic diseases and decline in functional performance (Idler 1993, Leinonen *et al.* 2001). In a 6-year follow-up study, the oldest old were more likely to report better health than younger people when comparing themselves with others of the same age (Dening *et al.* 1998).

Those who have never married or are divorced have been found to have significantly higher odds ratios of poor SRH than married/cohabitating people (Lindstrom 2009, Millan-Calenti *et al.* 2012), and a change in marital status has been shown to influence health longitudinally (Bennett 2006). Loss of a spouse has been thought to result in poorer health through several causal mechanisms, including emotional and practical support, spousal influence on health behaviors, and probably more and better quality health care utilization (Iwashyna & Christakis 2003, Umberson 1992).

Low income has been found to be associated with poor health among people with chronic diseases and disability (Cott *et al.* 1999), and poor SRH has been shown to be most common among persons who have experienced economic hardship (Molarius *et al.* 2007).

Walking difficulties

Functional limitations seem to have a significant effect on SRH, the most important ADL limitations being those involving mobility (Arnadottir *et al.* 2011, Gama *et al.* 2000, Hoeymans *et al.* 1997, Lindgren *et al.* 1994). Variables

significantly associated with poor SRH have been shown to be inability to go out alone and walking difficulties (Sun *et al.* 2007, Wang *et al.* 2006). Disability in mobility has been observed to result in poorer SRH among both sexes (Hoeymans *et al.* 1997, Jylha *et al.* 2001). However, the association between walking difficulties and SRH seems to weaken with age, and the association in the oldest age groups has been found to be non-significant (Hoeymans *et al.* 1997, Jylha *et al.* 2001).

Pain

Pain is related to low SRH, and the association between chronic pain and low SRH has been observed to increase with the frequency and severity of the pain (Cott *et al.* 1999, Mantyselka *et al.* 2003, Molarius & Janson 2002). In a cross-sectional study from Finland, daily chronic pain was found to relate to poor health even more strongly than chronic diseases or age (Mantyselka *et al.* 2003). The experience of pain and poor SRH has been found to be greatest among the most socially disadvantaged older adults (Reyes-Gibby *et al.* 2002).

Chronic diseases and comorbidity

SRH levels have been thought to reflect underlying disease burden, and disease-related symptoms and impairments have been found to explain much of the association between chronic disease and SRH (Tinetti *et al.* 2011). Cardiovascular diseases (CVD) have been found to be associated with poor SRH (Hoeymans *et al.* 1999, Kaplan *et al.* 1996, Venskutonyte *et al.* 2013), but on the other hand, SRH has been shown to be an independent predictor of future cardiovascular and cerebrovascular events (Weisen *et al.* 1999). Among the elderly, neurological disease and cancer have been observed to have the largest contribution to SRH in men, and renal disease, rheumatoid arthritis, and cancer in women (Molarius & Janson 2002). In a large longitudinal survey of 30,535 U.S. elderly living in Pennsylvania, increasing comorbidity was found to be associated with greater likelihood of deteriorated SRH, but the relationship was non-linear and the impact of comorbidity change appeared to be milder among older individuals and those with higher baseline comorbidity (Heller *et al.* 2009).

Cognitive impairment

Persons who reported subjective memory problems have not been shown to have poorer SRH scores, but those who were given a diagnosis of dementia by a physician have been found more likely to report poorer SRH than those without such recall (Campbell *et al.* 2008). On the other hand, in a community-based elderly cohort composed of 8,169 community-dwelling French persons aged 65 years or over (the 3C Study), poor or moderate SRH at baseline was observed to be a strong predictor of dementia in participants without cognitive complaints (Montlahuc *et al.* 2011).

Depression

When variables assessing physical health, difficulty with self-care, depressive symptoms, and cognitive impairment were pooled and harmonized from three Australian longitudinal studies of aging, poor SRH was found to become closely related to psychological symptoms, as people aged (French *et al.* 2012b). SRH has been shown to be independently associated with depressive symptoms even when controlling for gender, physical illness and functional disability (Han 2002, Millan-Calenti *et al.* 2012, Mulsant *et al.* 1997). Depression has been thought to influence SRH directly and to modify the way in which different physical conditions are reported (Molarius & Janson 2002).

Fatigue

Fatigue, defined as self-report of feeling tired most of the time over the prior month, was shown to have a significant negative impact on SRH among the elderly in a community-dwelling cohort from the Jerusalem Longitudinal Study. This has been suggested to be related to the complex relationship of fatigue with depression and levels of physical activity (Moreh *et al.* 2010).

Sensory impairments

Although vision and hearing impairments are common among the elderly, they appear not to affect perceived health to any large extent (Lindgren *et al.* 1994, Tay *et al.* 2005). According to the Blue Mountains Eye Study, a cross-sectional study conducted in Australia, impaired vision has been found to have an independent

impact on SRH among persons younger than 80 years, but not among older persons, possibly because the persons over 80 years may accept declined vision as an expected part of normal aging (Wang *et al.* 2000). Speech audiometry testing but not self-report of hearing impairment has been shown to be associated with poor SRH (Maggi *et al.* 1998).

2.3 Functional capacity

Functional capacity is one of the most important health measurements in the elderly. Various models have been introduced to describe the process leading from functional impairments to disability. The disablement process is often described as a process which progresses from pathology (diseases), to impairment, functional limitation, and ultimately to disability (Nagi 1964).

The World Health Organization (WHO) introduced in 2001 the International Classification of Functioning, Disability and Health (ICF), where functioning has been seen as multiple interactions or relationships between body functions and structures, activities, participation, health condition (disorders or diseases), environmental components and personal components. The interaction of these factors is in both directions, and interventions affecting one factor can potentially modify one or more of the other factors (World Health Organization 2001). Interactions between the factors associated with functional capacity are shown in Figure 1 below.

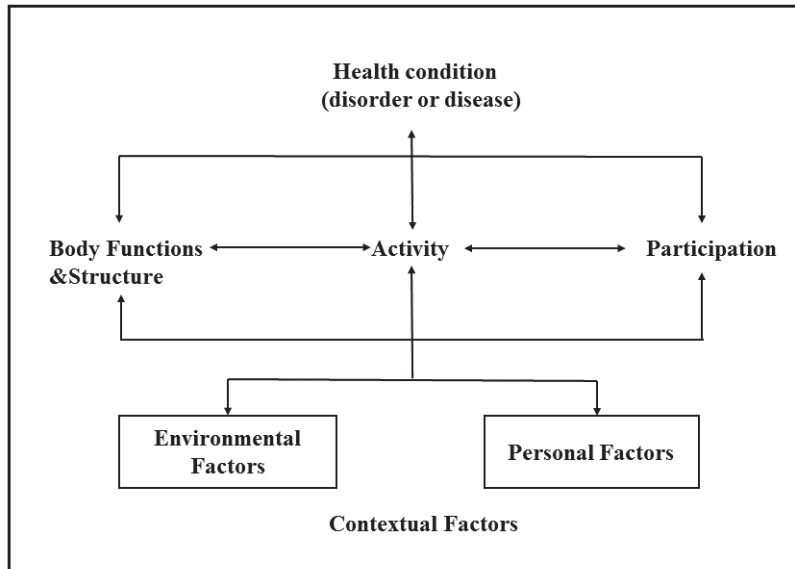


Fig. 1. Interactions between the factors associated with functional capacity. Modified from *International Classification of Functioning, Disability and Health: ICF*. Geneva, World Health Organization 2001 (published by permission of WHO).

The prevalence of self-reported disability among older people has been found to have declined significantly during recent decades around the world (Freedman *et al.* 2008, Helldán & Helakorpi 2014, Litwin *et al.* 2012, Manton 2008, Peres *et al.* 2005, Pitkala *et al.* 2001). According to the National Health Interview Surveys in the U.S., the proportion of people aged 70 and older who report disability has been observed to have declined by 1.38% per year between 1982 and 2003 (Martin *et al.* 2007). However, some studies have shown no significantly change in functional status (Fuller-Thomson *et al.* 2009) or even an increase in the prevalence of disability (Palacios-Cena *et al.* 2012).

As people get older, a larger proportion of disability have been shown to occur along a slower, progressive course as compared with more rapid onset, “catastrophic disability” (Ferrucci *et al.* 1996). Functional status among community-living older persons, particularly those who are physically frail, has been found to be a dynamic state where older adults’ functional status may

decline or improve (Gill & Kurland 2003, Nikolova *et al.* 2011). There has been thought to be a preclinical stage of physical disability, which precedes the onset of task difficulty. Such a stage provides a basis for identifying older adults at risk of becoming disabled (Fried *et al.* 2001b).

2.3.1 Evaluation of functional capacity

Functional status is often assessed using scales of ADL. ADLs can be divided into three sub-groups: 1) physical ADL or BADL, 2) IADL and 3) advanced activities of daily living (AADL). BADL represents activities meeting the basic physiological and self-maintenance needs. The most common index of BADL was developed to study results of treatment and prognosis in the elderly and chronically ill (Katz *et al.* 1963). The index ranks the performance in bathing, dressing, going to toilet, transferring (into the bed/out of bed), continence and feeding. The IADL measures are oriented to interactions with the environment and are more complex than BADL (Lawton & Brody 1969). IADLs and BADLs are essential for maintaining independent living, but IADLs are usually optional or can be delegated (e.g., care of pets, financial management, meal preparation, cleaning and shopping). IADL is a more sensitive predictor of functional decline than BADL, and limitations to it typically develop before the onset of those of BADL (Judge *et al.* 1996, McGuire *et al.* 2006). AADL are more sophisticated activities, beyond those necessary to live independently (Reuben *et al.* 1990).

In a systematic literature review, Stuck *et al.* introduced the term “functional status decline,” which is defined as having both difficulty doing activities of daily life and physical function limitation (Stuck *et al.* 1999). According to Stuck *et al.*, the highest strength of evidence for an increased risk of functional status decline was found for (in alphabetical order) cognitive impairment, depression, disease burden (comorbidity), increased and decreased body mass index, lower extremity functional limitation, low frequency of social contacts, low level of physical activity, no alcohol use compared to moderate use, poor self-perceived health, smoking and vision impairment. Among two Medicare-eligible-persons cohorts (1991–1996 and 1994–1999) in four U.S. communities, the five-year change in 13 key measures of standardized health (hospitalization, bed days, cognition, extremity strength, feelings about life as a whole, satisfaction with the purpose of life, SRH, depression, digit symbol substitution test, grip strength, BADL, IADL, and gait speed) has been found to be the greatest in BADL, IADL and gait speed.

These rankings were independent of age, sex, mortality patterns and the method of standardization (Diehr *et al.* 2013).

Both self-reported and performance-based measures have been used to evaluate functional capacity among the elderly. They have been found to complement each other, although performance tests examine functional limitations and may detect them before becoming measurable by traditional self-reported BADL and IADL scales, whereas self-reported ADL reflects disability (Kivinen *et al.* 1998, Rozzini *et al.* 1997). Among older women without difficulties in mobility, performance measures and self-reported task modification have seemed to be independent and strong predictors of risk of future mobility disability (Fried *et al.* 2000, Fried *et al.* 2001b). The inability to perform certain tasks may be related either to the effects of a single condition on most or all ADLs or to the independent effects of several conditions, each of which affect only a few activities (McDaid *et al.* 2013, Wang *et al.* 2002). Motor impairments and depressive symptoms in particular have been thought to act as single conditions with their main effects on disability (Kempen *et al.* 1998).

2.3.2 Determinants of functional capacity

Health behaviors

Fogel & Costa introduced in 1997 a theory of “technophysio evolution”, where declines in disability are seen as a consequence of declines in both chronic disease and disability occurring over the past century due to improved nutrition, sanitation, and education (Fogel & Costa 1997). Older people who do not consume vegetables and/or fruits daily have been shown to have a poorer functional capacity than daily consumers (Sulander 2011). Overweight and obesity are significant predictors of functional impairment, and even lower levels of obesity have been found to be associated with new or worsening disability within 2 years among U.S. adults aged 65 years or older (Wee *et al.* 2011).

Physical activity among community-dwelling older persons has been shown to be associated with the maintenance of functional status, including a reduced risk of developing impairment in BADL and IADL (Boyle *et al.* 2007, Sulander 2011), and a long-term structured physical activity program has recently been found to reduce major mobility disability among older adults at risk for disability in a randomized clinical trial (Pahor *et al.* 2014). Higher physical activity since midlife has been

observed to be strongly associated with less frailty in old age (Savela *et al.* 2013), as well as less end-of-life inpatient care (von Bonsdorff *et al.* 2009). In a Spanish population-based survey, the prevalence of disability among the elderly increased from 2000 to 2007, and variables associated with higher disability were age over 84 years, lower education levels, obesity, not practicing physical activity and sleeping more than 8 hours per day (Palacios-Cena *et al.* 2012). It has been observed that not only do persons with better health habits survive longer, but in such persons, disability is postponed and compressed into fewer years at the end of life (Vita *et al.* 1998).

Sociodemographic factors

Age has been shown to be significantly associated with changes in disability when socio-economic variation is taken into account (Grundy & Glaser 2000, McGee *et al.* 1998, Tas *et al.* 2011). However, Freedman *et al.* showed in their systematic review that in the last decades, self-reported disability has been pushed to the later years of life (Freedman *et al.* 2002). The incidence of functional disability in elderly men and women has shown conflicting results, with some studies indicating higher incidence in women (Beckett *et al.* 1996, Crimmins *et al.* 2011, Leveille *et al.* 2000), one study in men (Grundy & Glaser 2000), and still others with no difference between genders (Oman *et al.* 1999, Rodrigues *et al.* 2009, Tas *et al.* 2007). The higher prevalence of disability in women has been thought to be explained by a longer duration of disability due to women's longer survival from the onset of disability (McGee *et al.* 1998, Oman *et al.* 1999).

Dissatisfaction with social relations has been found to be significantly associated with onset of disability for both genders. Living alone and low social participation have been shown to be significant risk factors for later disability among men. Women have not been observed to benefit as much from cohabitation as men, although women who live alone and who are not satisfied with their social relations also constitute a significant risk category for functional status decline (Lund *et al.* 2010).

In longitudinal analyses, self-perceived adequacy of income has been observed to predict onset of disability (Matthews *et al.* 2005, Sulander *et al.* 2012). Higher education and income have been shown to be related to better functional capacity, and the associations have been stated to remain even after adjusting for smoking, physical activity and number of chronic diseases (Rautio *et al.* 2005).

Pain

Both self-reported and performance-based functional limitations and the need for help in daily living have been shown to be more common among the elderly with pain than those without pain, especially among the oldest old (Jakobsson *et al.* 2003, Leveille *et al.* 1999). In the 2004 Health and Retirement Study, a nationally representative study of 18,531 community-living persons aged 50 and older in the U.S., subjects with pain were found to develop the functional limitations classically associated with aging at much earlier ages than subjects without pain (Covinsky *et al.* 2009). Impairment in performing ADL has also been observed to increase with pain severity and with the number of painful sites (Soldato *et al.* 2007). Among older adults with arthritis and comorbid depression, improved depression care has been found to decrease pain and to improve functional status and quality of life (Lin *et al.* 2003).

Chronic diseases

In 1980, Fries generated the idea of “the compression of morbidity,” where the period of senescence has been thought to be compressed near the end of life (Fries 1980). Health trends among elderly population have shown that although the prevalence of most diseases has increased in the older population as people survive longer with disease, having a disease appears to be less disabling at present than in the past (Crimmins 2004, Parker & Thorslund 2007). Among an unselected cohort of 85-year-olds in the Newcastle 85+ Study, the participants showed good levels of functional ability, although the prevalence of diseases was high (Collerton *et al.* 2009).

Both acute events and slowly progressive diseases can be the underlying causes of physical disability (Fried & Guralnik 1997). In general, stroke, depressive symptoms, hip fracture, knee osteoarthritis, diabetes, chronic obstructive pulmonary disease and heart diseases have been shown to account for more physical disability in the non-institutionalized elderly than other diseases (Ali *et al.* 2009, Bertram *et al.* 2011, Corti & Rigon 2003, Creamer *et al.* 2000, Guccione *et al.* 1994, Isoaho *et al.* 1995, Moussavi *et al.* 2007, Pinsky *et al.* 1990, Rost *et al.* 2008, Sinclair *et al.* 2008, Stenholm *et al.* 2015, Verbrugge *et al.* 1991). Having two or more diseases (multimorbidity) has also been found to be associated with poorer physical function (Bayliss *et al.* 2004, Fried & Guralnik 1997, Kadam *et al.* 2007, Stenholm *et al.* 2015).

Cognitive impairment

Cognitive impairment was observed to be a more powerful predictor of impaired BADL than an individual's disease burden in a population-based survey of 2,192 over 65-year-old Italian adults (Scanlan *et al.* 2007), but among subjects with cognitive impairment or dementia, the existence of another chronic condition increased functional dependence in both BADL and IADL (Aguero-Torres *et al.* 2002). Impairments in physical performance and cognitive status have been found to contribute independently to the risk of functional dependence in nondisabled, community-living older adults (Gill *et al.* 1996), and they appear to influence one another's development (Black & Rush 2002). There are differences in functional impairment across subtypes of dementia; vascular dementia has been shown to be associated significantly more often with ADL limitations than Alzheimer's disease (Gure *et al.* 2010). It has been suggested that factors other than cognition, such as motivation or perceptual, sensory and motor abilities, may be important in IADL performance (Sauvaget *et al.* 2002).

Depression

In the Upper Bavarian longitudinal community study (1975–2004), depression was found to predispose for functional impairment (Fichter *et al.* 2008). The excess risk of disability has been explained by depressed persons' decreased physical activity and social interaction (Penninx *et al.* 1999). Depression in previously non-depressed persons has been shown to be an increased risk for functional inabilities, even when controlling for age, sociodemographic factors, physical diseases, and baseline disabilities (Kivela & Pahkala 2001, Penninx *et al.* 1998). On the other hand, declining ADL has been shown to be associated with late onset of depression (Alexopoulos *et al.* 1996, Kempen *et al.* 1998, Weinberger *et al.* 2009, Williams *et al.* 1995). Among patients with Alzheimer's disease, the presence and severity of depression has been observed to predict functional status, with the degree of association varying by level of cognitive impairment (Fitz & Teri 1994), and community-dwelling elderly people with both cognitive impairment and depressive symptoms have been found to have functional limitations more often than those with either cognitive impairment or depressive symptoms alone (Millan-Calenti *et al.* 2011).

Fatigue

Fatigue has been shown to be one of the most common reasons given by community-dwelling older adults for restricted activity (Gill *et al.* 2001). Avlund *et al.* found in their 5-year longitudinal study among nondisabled 75-year-old persons in Finland and Denmark that persons who reported fatigue had a larger risk of becoming disabled in ADL and mobility compared with persons without tiredness (Avlund *et al.* 2002). The association of fatigue with functional deficits has been suggested to persist for several years (Hardy & Studenski 2008a).

Sensory impairments

Both visual and hearing impairments have been shown to have an independent impact on subsequent functioning (Cacciatore *et al.* 2004, Chen *et al.* 2014b, Jacobs *et al.* 2005, Sloan *et al.* 2005), but vision impairment was found to exert a more extensive impact than hearing impairment on functional status in a 1-year prospective cohort study of 2442 community-dwelling people age 50 to 102 from California (Wallhagen *et al.* 2001). Loss in vision or hearing has also been shown to be able to exacerbate the effects of other impairments on disability (Kempen *et al.* 1998).

2.4 Walking difficulties

Mobility, measured by self-reported ability to walk 0.25 mile, has been observed to be a powerful predictor of subsequent disability (Hardy *et al.* 2011). The overall prevalence of gait disorders (neurological, non-neurological or both) among persons over age 70 has been found to be 35%, with no difference between men and women (Verghese *et al.* 2006). In the U.S., almost half of community-dwelling Medicare beneficiaries aged 65 years and older reported limited ability to walk 0.25 mile in 2003 (Hardy *et al.* 2010). In six low- and middle-income countries (China, India, Russia, South Africa, Ghana, and Mexico), 42% to 76% of people aged 65 years and older reported some difficulty in walking 1 km (Capistrant *et al.* 2014). According to the Health 2000 Health Examination Survey, 59% of 75–84-year-old Finnish men reported being able to walk 500 m without difficulties in 2000; among women, the proportion was 47%. Between 1980 and 2000, the proportion of people aged 65 or over who reported being able to walk 500 m without difficulties increased from 56% to 72% among

men and from 55% to 65% among women (Aromaa & Koskinen 2004). This is in agreement with the Health Behaviour and Health among the Finnish Elderly survey, where the proportion of 65–84-year-olds who reported being able to walk outside without difficulties was found to have increased between 1993 and 2013 from 80% to 91% among men and from 77% to 87% among women (Helldán & Helakorpi 2014).

Peel *et al.* showed in a systemic review that gait speed is an important measure of functional capacity in comprehensive geriatric assessment (Peel *et al.* 2013), and measured by a timed 4- to 6-meter walk at the patient's usual pace, it was found to be a predictive factor for ADL (Abellan van Kan *et al.* 2009, Cesari *et al.* 2005, Cummings *et al.* 2014, Viccaro *et al.* 2011). Low walking speed is also one criterion of frailty (Fried *et al.* 2001a).

In a cross-sectional study of 9,563 community-dwelling Medicare beneficiaries aged 65 and older in the U.S., difficulties in mobility tasks was found to be independently associated with increasing age, female gender and most chronic medical conditions, such as cardiovascular diseases (CVD), diabetes, chronic lung diseases, cancer, neurological diseases, lower body arthritis, osteoporosis and psychiatric comorbidity (Hardy *et al.* 2010). However, among the oldest old in the Leiden 85-plus Study in the Netherlands, general impairments (cognitive impairment, depressive symptoms and dizziness upon rising) was observed to contribute more substantially to walking disability than do common chronic diseases (Bootsma-van der Wiel *et al.* 2002). Lower-extremity function has been suggested to predict the development of disability because it reflects the effects of chronic disease, coexisting conditions and physiological decline that have not yet caused disability (Guralnik *et al.* 1995, Hardy *et al.* 2011).

2.5 Life expectancy and mortality

Life expectancy at age 65 has increased significantly among both men and women in all European Union member states (OECD 2012). As life expectancy has increased, the number of healthy years lost to disability has also increased in most countries. According to the Global Burden Disease Study concerning 187 countries, global male healthy life expectancy (HALE) at birth was 58.3 years in 2010 and global female HALE 61.8 years, respectively. HALE has increased more slowly than life expectancy over the past 20 years, with each 1-year increase

in life expectancy at birth associated with a 0.8-year increase in HALE (Salomon *et al.* 2012).

Ischemic heart diseases and stroke are the most common causes of death worldwide and in Finland (Official Statistics of Finland 2014, World Health Organization 2014). The major CVD risk factors, such as increasing age, male gender, increase in systolic blood pressure, total cholesterol/HDL ratio and smoking, have been found to increase long-term risk of total mortality (Mannan *et al.* 2013, Menotti *et al.* 2001a), and a healthy diet has been shown to be associated with decreased risk of total, CVD, and cancer mortality among older adults (Reedy *et al.* 2014).

It has been suggested that psychological or physical trauma and stress in young adulthood may have lifelong effects on veterans' health and lead to increased mortality in late adulthood (Bramsen *et al.* 2007, Elder *et al.* 1997, Kunnas *et al.* 2011, Page & Brass 2001). At age 85 in the U.S., the excess mortality has been shown to be considerable among functionally dependent veterans compared with non-veterans (Liu *et al.* 2006).

2.5.1 Predictors of life expectancy and mortality

Conflicting results have been shown concerning the predictors of mortality among the oldest old. In the Vitality 90+ study, the same health indicators that are important at younger old age, such as older age, male gender, disability in ADL and mobility, poor SRH and institutionalization were found to predict mortality among individuals aged 90 and older (Tiainen *et al.* 2013), whereas Nybo *et al.* stated that several known risk factors of mortality, such as sociodemographic factors, smoking, and obesity, lose their importance in predicting mortality among the oldest old (Nybo *et al.* 2003).

Sociodemographic factors

Non-married older persons have been shown to have higher mortality than married persons (Koskinen *et al.* 2007, Manzoli *et al.* 2007), the relative differences being greatest in deaths from alcohol-related causes, followed by deaths from accidents among men. Koskinen *et al.* analyzed mortality by cause of death in the total Finnish population aged 30 or over in 1996–2000 and noticed that older men living alone did not differ from other non-married groups (cohabiting or living with someone other than a partner). Older women living

alone, however, had slightly higher mortality than married women (Koskinen *et al.* 2007). Feeling lonely rather than social isolation factors has been found to be a major risk factor for increasing mortality in older men but not in older women (Holwerda *et al.* 2012).

Self-rated health

Idler & Benyamini showed in their review of 27 community studies that global SRH is an independent predictor of mortality, despite the inclusion of numerous specific health status indicators and other relevant covariates known to predict mortality (Idler & Benyamini 1997). In their meta-analysis, DeSalvo *et al.* found that the association of SRH with mortality remained significant even after adjustment for key covariates such as functional status, depression and comorbidity (DeSalvo *et al.* 2006). Jylhä suggested in her review that the advantage of global self-ratings for predicting mortality is partly due to the limitations in the health variables that the empirical studies can include, and partly to people's ability to use the sensations of their bodies in self-ratings of health (Jylha 2009). A strong age-adjusted association has been found between the level of SRH and total, CVD and cancer mortality (Giltay *et al.* 2012, Kaplan *et al.* 1996). SRH transition has been thought to be a better predictor of survival after major medical events than SRH status (Hillen *et al.* 2003). However, the protective effect of good SRH for mortality is not significant among those with impaired ADL, possibly because they are already too sick to be protected by better self-ratings of health (Murata *et al.* 2006).

Functional capacity

ADL disability was observed to result in diminished survival after adjusting for known risk factors including advanced age, stroke, and cancer in a community-based study which evaluated 1-, 5-, and 10-year survival and time to death among 9,447 participants aged 70 and older (Stineman *et al.* 2012). The life expectancy of an ADL-disabled 75-year-old person has been found to be similar to that of an 85-year-old independent person, the impact of the disability approximates being 10 years older with much more of the remaining life spent disabled (Keeler *et al.* 2010). Although shorter life expectancy among those with mild disability can be explained by diseases and other risk factors, the independent effect of more severe disabilities on mortality cannot be ruled out (Majer *et al.* 2011).

Walking difficulties

Persistent self-reported mobility deficit (e.g., difficulties in walking, climbing stairs and rising from a chair) has been found to be associated with an increased risk of mortality without first passing through ADL disability (Khokhar *et al.* 2001). Self-reported mobility impairments and physical inactivity have been shown to be risk factors for mortality in a population-based, prospective study among Finnish elderly persons (Hirvensalo *et al.* 2000). Analysis of longitudinal data from the Medicare Current Beneficiary Survey (2003–2004) has observed that after adjustment for demographics, socioeconomic status, chronic conditions and health behaviors, mortality rates were higher among those who reported difficulty or inability to walk 0.25 miles compared with those without walking difficulties (Hardy *et al.* 2011). A usual gait speed of less than 1 m/s has been found to be a consistent risk factor for mortality among well-functioning older people (Cesari *et al.* 2005), and tiredness in mobility has been found to be an independent predictor of mortality during the next 10 years (Avlund *et al.* 1998). Among those who completed 400 m walking, each additional minute of performance time was shown to be associated with a higher mortality in a cohort study enrolling 3,075 community-dwelling adults aged 70 to 79 years (Newman *et al.* 2006).

Levels of physical activity and mobility status have been observed to appear partly distinct as predictors of mortality. However, in older people with impaired mobility, higher levels of physical activity have been observed to reduce the risk of mortality (Hirvensalo *et al.* 2000).

Chronic conditions

In a systemic literature review, Kane *et al.* found that seven geriatric syndromes (multiple comorbidities, cognitive impairment, frailty, disability, malnutrition, impaired homeostasis and chronic inflammation) were associated with poor survival (Kane *et al.* 2012). Cognitive impairment, even in the absence of manifest dementia, has been shown to increase the risk of mortality independent of other mortality risk factors, the risk of mortality rising with the severity of the dementia (Andersen *et al.* 2010, Perna *et al.* 2014, Sachs *et al.* 2011, Villarejo *et al.* 2011). In a large Swedish cohort study, adjusted risk for mortality was lowest among Alzheimer's disease patients and highest among those with frontotemporal dementia (Garcia-Ptacek *et al.* 2014).

Depressive syndromes have been found to increase the risk of death among both genders in longitudinal settings, the severity and chronicity of depression being associated with a higher mortality risk (Pulska *et al.* 1999, Schoevers *et al.* 2009). Avlund stated in her literature review that fatigue is an early indicator of the aging process (Avlund 2010), and it has been found to predict mortality in older adults up to the oldest old (Avlund 2010, Hardy & Studenski 2008b, Moreh *et al.* 2010). Urinary incontinence as a predictor of mortality has been suggested to be a marker of frailty, and severe baseline illnesses and functional impairment have been thought to mediate the relationship between urinary incontinence and mortality (Holroyd-Leduc *et al.* 2004).

Multimorbidity

Multimorbidity is defined as the co-occurrence of two or more diseases or active health conditions. It has been suggested that a single underlying cause accounts inadequately for mortality in elderly people with coexisting diseases, leading to underestimation of the contribution of some diseases (such as dementia and respiratory disease) to death and overestimation of the contribution of others (Tinetti *et al.* 2012). Controversial results have been found on the effect of multimorbidity on mortality; in some studies an increasing number of coexisting diseases have been shown to be significantly related to an increasing risk of mortality (Menotti *et al.* 2001b, Tooth *et al.* 2008) but not in others (Landi *et al.* 2010, Marengoni *et al.* 2009).

Sensory impairments

A connection has been found between mortality and vision and hearing impairment (Cacciatore *et al.* 2004, Feeny *et al.* 2012). In the Blue Mountains Eye and Hearing Studies, population-based surveys conducted in Australia, the connection between visual impairment and mortality was observed to be mediated directly and indirectly via disability in walking (Karpa *et al.* 2009), and the connection between hearing loss and mortality indirectly via disability in walking, SRH and cognitive impairment (Karpa *et al.* 2010). Objectively measured dual (both visual and hearing) sensory impairment has been shown to be an independent predictor of total mortality in older adults and has been approved to be associated with a risk of death greater than that of either vision or hearing loss alone (Gopinath *et al.* 2013).

Falls

In a systematic review and meta-analysis, mortality rate among the geriatric population with traumatic injuries was found to be higher than that among the adult trauma population (Hashmi *et al.* 2014). Ground-level falls have been shown to be associated with significant mortality among patients older than 70 years, those patients being more likely to experience long-bone or pelvic fracture or intracranial injury than patients younger than 70 years (Spaniolas *et al.* 2010). Same-level falls as a cause of death have been found to be 10 times more common among patients over 65 years than among younger patients (Sterling *et al.* 2001). Among elderly women, high frequency of falls has been found to independently predict mortality (Sylliaas *et al.* 2009).

3 Aims of the study

This thesis is based on the Veteran 1992 Project and the Veteran 2004 Project surveys. The general aim was to focus on determinants and changes in SRH and on determinants of functional capacity, especially on that of ability to walk. Finally, the aim was to identify risk factors and their combinations that predict late-life mortality among Finnish Second World War veterans. The specific aims of the study were:

1. To investigate trends in health status among 80–84-year-old Finnish war veterans in 1992 and 2004 and to investigate the determinants of ability to walk 500 m outdoors without disability (Study I).
2. To examine changes in SRH from 1992 to 2004 and to analyze the independent determinants of the declined SRH during the 12-year follow-up among the 4999 veterans who participated in both surveys (Study II).
3. To study the ability of physical and mental conditions in 1992 to predict functional status impairment in 2004 and to determine whether the worsening of symptoms or the onset of new diseases during 1992–2004 was associated with impaired BADL and IADL in 2004 (Study III).
4. To explore veterans' mortality and to determine whether the same risk factors that have been shown in previous studies to be significant for mortality predict late-life mortality among Finnish war veterans during an average 9.9-year follow-up (Study IV).

4 Subjects and methods

4.1 Populations of the Veteran 1992 Project and the Veteran 2004 Project surveys

In this thesis, a definition “war veteran” refers to both men and women who served in the Finnish Defense Forces between 1939 and 1944 and were awarded a front military code by the provincial military headquarters (men) or a front service code from the voluntary auxiliary service by the Ministry of Defense (women). “Men with disability” refers to veteran men who were injured or fell severely ill during the war and who have a disability percentage defined by the State Treasury.

The baseline survey, the Veteran 1992 Project, was conducted with the entire cohort of Finnish Second World War veterans living in Finland and receiving a frontline veteran’s pension or frontline increment from the Social Insurance Institution. In 1992, a postal questionnaire was sent to 242,720 veterans (191,525 men and 51,195 women). The total number of participants was 177,990 men and 48,747 women (with a participation rate of 93%). In 1992, the number of Finnish men aged 65 or over was 250,906 (Statistics Finland 2015), and 76% of them were war veterans. Men born in 1925 were the youngest age-group involved in the Second World War as a whole.

A follow-up study, the Veteran 2004 Project, was conducted with a stratified random sample of 5,750 war veterans (3,000 men without disability, 2,000 men with disability and 750 women) who had also participated in the Veteran 1992 Project. The total number of participants in the follow-up survey was 4,348 men and 651 women (with a participation rate of 87%).

Men with missing information about disability (n=706) were excluded from the study population, as well as native Swedish-speaking men (n=13,792), whose data in the Veteran 2004 Project was incomplete for technical reasons. In Study II, veterans with missing information about the change in SRH (n=80), and in Study IV veterans who died before November 23 1992 (n=304) were also excluded.

4.2 Survey methods

The Ministry of Social Affairs and Health delegated the National Institute for Health and Welfare (formerly the National Public Health Institute in Finland) to

conduct both surveys as postal surveys in cooperation with the Finnish regional and local authorities and the veterans' own organizations. Information about those veterans who were receiving the frontline veteran's supplement was obtained from the Social Insurance Institution of Finland.

The baseline survey was carried out from November 1992 to November 1993. In the baseline survey, the self-administered questionnaire comprised 36 multiple-choice questions, including questions about the veterans' SRH and disorders, functional capacity, use of technical aids and services (health care, rehabilitation and social services) and living conditions, and the veterans' own views on their requirements for further services. The follow-up survey was carried out in April 2004 and comprised 30 identical and 27 additional questions. In 1992, the veterans were asked about becoming ill or being wounded or permanently disabled during the war. These questions were not repeated later. In 2004, additional questions focused on the veterans' functional capacity, as well as their spouses' state of health and need for services. The questionnaires were filled in by the veterans themselves or by a personal assistant. Non-respondents were reminded once.

The validity of the questions was studied in 1992 by two means. Firstly, the structure of the questionnaire and the division of the answers were compared with previous geriatric studies in Finland, where similar questions had proved reliable (Heikkinen 1997, Helldán & Helakorpi 2014). Secondly, a general practitioner conducted health examinations for 100 veterans who completed the questionnaire in 1992 (Ryynanen et al. 1994). The results were quite similar, although the general practitioner rated the veterans' health to be better than did the veterans themselves.

The sociodemographic characteristics of the Veteran 1992 Project and 2004 Project survey populations are presented in Table 1.

Table 1. Sociodemographic characteristics of Finnish war veterans in 1992 and 2004.

Variables	Men without disability		Men with disability		Women	
	Study year		Study year		Study year	
	1992	2004	1992	2004	1992	2004
Number of subjects	129,853	2,615	33,639	1,733	48,747	651
Mean age (y)	73.6	82.2	73.7	83.2	72.7	82.3
Marital status						
Single	5.9	4.5	5.0	3.8	14.0	11.1
Cohabiting or married	72.7	65.9	75.4	67.6	38.3	22.3
Divorced	4.8	3.4	4.3	3.3	6.6	6.2
Widowed	16.5	26.3	15.3	25.3	41.1	60.4
Living arrangement						
Alone	20.6	30.6	18.5	28.6	50.6	68.4
With cohabitant or spouse	64.7	60.5	67.2	59.6	35.1	20.6
In institutional care	3.2	2.5	2.9	4.0	2.6	4.5

Values are percentages

4.3 Study design

This thesis is based on the Veteran 1992 Project and the Veteran 2004 Project surveys. Study I was a cross-sectional study, where the health status and functional capacity of the 80–84-year-old Finnish war veterans were assessed in 1992 and 2004. In 1992, the study population comprised 16,109 veteran men without disability, 3,681 veteran men with disability and 4,198 women, and in 2004, 1,293 men without disability, 1,011 men with disability and 346 women. Studies II and III were 12-year longitudinal studies, the study populations comprising those 4,999 war veterans who participated in both the Veteran 1992 and Veteran 2004 Project surveys. Study IV was a prospective follow-up study based on the study population of the Veteran 1992 Project survey population. The average follow-up time was 9.9 years. For the 226,734 veterans with complete information in Study IV, mortality data were collected from the Finnish national Causes of Death Register administered by Statistics Finland and linked to the survey using the personal identification numbers that are assigned to every resident of Finland. Thus the mortality follow-up and the ascertainment of the living status (i.e. whether they were dead or alive) were complete.

4.4 Definitions of study outcomes

4.4.1 Self-rated health

SRH was determined by requesting the veterans to assess their health compared with the health of others in their age group as “very good”, “good”, “moderate”, “rather poor” or “poor”.

In Study I, the definition “good health” was used to refer subjects with both very good and good SRH. In Study II, the definition “improved or unchanged self-rated health” was used to refer to subjects whose SRH had improved or stayed stable during the follow-up, and “declined self-rated health” to subjects with declined SRH. In Study IV, the definition “impaired self-rated health” refers to subjects with “rather poor” or “poor” SRH.

4.4.2 Functional capacity

In Study III, veterans’ functional capacity in 2004 was assessed using scales for BADL and IADL. The BADL checklist in this study included bathing, dressing, toileting, transferring (into the bed and out of bed), eating unaided and continence, according to the Katz BADL scale (Katz *et al.* 1963). Five IADL tasks from the Lawton-Brody IADL scale (Lawton & Brody 1969) considered to enable an independent life in the community were chosen: the ability to use the telephone, do shopping, do light housework, self-manage medication and handle finances.

The ability to cope with each activity of daily life was assessed by asking: “How do you manage with the following activities of daily life?” The alternatives were “without difficulty”, “some difficulties”, “a lot of difficulties”, “can’t manage without help” and “completely assisted”. “Impaired BADL or IADL” was used to refer to any of the last four categories. Urinary incontinence was assessed by asking: “Have you urinated involuntarily during the past month?” where “impaired urinary continence” refers to the subjects with involuntary urinating. Because of the skewness of the distributions, the sum scores in BADL and IADL were dichotomized into two outcome variables: no decline in any of the items constituted the sum score, coded as 0, and declined ability in performing one or more of the items, coded as 1.

Ability to walk

Ability to walk 500 m outdoors was assessed with the alternatives “yes, without difficulty”, “yes, but it is difficult”, “yes, but I have to rest many times” or “no, I cannot”. In Studies I, III and IV “walking difficulties” and in Study II “severe walking difficulties” were used to refer to the last three categories. “Increased walking difficulties” refers to a subject who reported having deteriorated walking during the follow-up.

4.4.3 Mortality

The ninth and tenth revisions of the International Classification of Diseases (ICD) were used to identify fatal cardiovascular disease (CVD) (I00–I425, I427–I99 [ICD-10]/ 390–4254, 4258–434, 436–4376, 4378X–444, 447–459 [ICD-9]), fatal coronary heart disease (CHD) (I20–I25, I46 [ICD-10] / 410–414, 798 (not 7980A) [ICD-9]), fatal stroke (I61, I63 (not I636), I64 [ICD-10] / 431, 4330A, 4331A, 4339A, 4340A, 4341A, 4349A, 436 [ICD-9]) and death due to accidents and violence (AAV), including environmental events, circumstances and conditions as the cause of injury, poisoning, and other adverse effects (V01–X44, X46–Y89 (not X45, X6, X7, X80, X81, X82, X83, X84, Y9) [ICD-10]/ E800–E999 (not E850, E851, E95) [ICD-9]). The validity of data obtained from the Causes of Death Register has been determined in previous studies (Leppala *et al.* 1999, Mahonen *et al.* 2013, Pajunen *et al.* 2005, Rapola *et al.* 1997).

4.5 Definitions of study variables

4.5.1 Self-reported physical or mental conditions

Self-reported recurrent or continuous pain during the past month was assessed with the alternatives “no pain”, “slight pain”, “moderate pain” or “severe pain”. In Study I, “painlessness” was used to refer to subjects with no self-reported pain and those with slight pain. In Studies II to IV, “pain” refers to all others than “no pain”.

“Vision impairment” refers to subjects who were unable to read newspapers or books with or without glasses. “Hearing impairment” was present when a person with poor hearing had extensive difficulties in conversation with other people.

“Memory impairment” was used when impaired memory significantly interfered with daily life (Study II and IV) or if a severe cognitive impairment was reported to have been diagnosed by a doctor (Study II and III).

Depression and severe fatigue were classified into four categories: “never”, “sometimes”, “often” or “always”, and subjects with “depression” and “fatigue” were those who reported suffering from the conditions “often” or “always”.

“Increased pain or fatigue” and “impaired vision, hearing or memory problems” refers to a subject who reported having increasing pain or fatigue or deteriorated vision, hearing or memory during 1992 to 2004.

Falls were assessed by asking: “Have you fallen during the past month?”

4.5.2 Self-reported diseases

Information about diseases was based upon the replies to the question: “In the past year, have you been diagnosed with or treated for the following illnesses by a doctor?”

In Study I, “heart disease” referred to heart attack, coronary disease or heart failure. In Studies II and III, the definition CVD referred to heart attack, coronary disease or heart failure, and additionally diabetes, because diabetes substantially increases the risk of CVD (Creager *et al.* 2003). In Study IV, diabetes was not included in the definition of CVD. In Studies II and III, “musculoskeletal disease” referred to rheumatoid arthritis, osteoarthritis in the hip, knee, shoulder joint or back or other back disorders and “neurological disease” to Parkinson’s disease or stroke. In Study II, “onset of depression, a new CVD or musculoskeletal or neurological disease” referred to subjects with a new onset of the disease during 1992 to 2004.

4.6 Statistical methods

Statistical analyses were performed using SPSS versions 12.0 (Study I), 18.0 (Study II) and 19.0 (Study III) for Windows software (SPSS Inc., Chicago, IL, USA). In Study IV, statistical analyses were carried out using Base SAS, version 9.3 (SAS Institute, Inc., Cary NC), except for mortality rates, which were calculated using Stata Intercooled version 11.2 (StataCorp LP, Inc., College Station TX). All analyses were conducted separately for men without disability, men with disability and women. Women were analyzed as one group, because only 2% of women who answered the questionnaire in 1992 had a disability.

The proportions of specified categorical variables by study year (1992 and 2004) and by the differences in changes over time between the improved/unchanged and declined SRH groups were compared using the chi-squared test, statistically significant p values being <0.05.

The multivariate logistic regression model was used to determine the effect of specified variables for walking 500 m without difficulties (adjusted for good SRH, painlessness, heart disease, rheumatoid arthritis or osteoarthritis, depression, fatigue, hospital care during the last 12 months and rehabilitation in a rehabilitation facility or in outpatient care) and for declined SRH (adjusted for age and marital status, impaired ability to walk, increased pain, impaired vision, hearing and memory, increased fatigue, onset of depression, a new CVD, musculoskeletal or neurological disease and institutionalization). To predict the effect of self-reported physical and mental conditions in 1992 on the impaired BADL and IADL in 2004, a multivariate logistic regression model adjusted for age and baseline variables (pain, walking difficulties, vision, hearing and memory impairment, fatigue, depression, CVD, musculoskeletal and neurological disease) was employed. A model where each variable separately, then all variables simultaneously, were adjusted for the baseline value and age were used to assess the association of worsening symptoms or the onset of a new disease during the follow-up with the impaired BADL and IADL. Odds ratios (OR) and 95% confidence intervals (CI) were given for the dichotomous (yes/no) variables, except for age, which was a continuous variable.

In order to define hazard ratios (HR) for the main outcomes of interest (total, CVD and AAV mortality), multivariate analyses were performed using the Cox proportional hazard regression model, which allows for simultaneous exploration of the effects of several explanatory variables on survival. Explanatory variables (age, impaired SRH, walking difficulties, falls, impaired vision, hearing and memory, fatigue, depression, multimorbidity, urinary incontinence, living alone) were selected for the model based on the integrated discrimination improvement index (IDI), a tool for evaluating the capacity of a variable to predict a binary outcome of interest (Kerr *et al.* 2011), and the net reclassification improvement index (NRI), which measures models' capacity to discriminate between persons who will experience death during the follow-up from those who will not (Sundstrom *et al.* 2011). A model with age as the only explanatory variable was used as a starting point. A forward selection approach was then used by selecting a variable that provided the maximum IDI value, and adding variables to the model until all IDI values were less than 0 or non-significant ($p \geq 0.05$). Another

criterion for variable inclusion was that NRI was greater than 0. This model was selected because the majority of veterans died during the follow-up and in traditional models all of the chosen predictive variables would have been statistically significant. Censoring occurred if a veteran was alive at the end of the study. The proportion of missing data was 0–11% among the variables. Imputed data was used in modeling, and the nearest neighbor method was used to find the most similar data.

4.7 Ethical considerations

The study was conducted with the permission of the Ministry of Social Affairs and Health, and the study protocol was approved by the Research Ethics Committee of the National Institute for Health and Welfare. On the basis of these permissions, licenses for the required data were obtained from the registration authorities. The data is stored at the National Institute for Health and Welfare in Helsinki.

5 Results

As expected, the prevalence of self-reported physical and mental conditions increased among the 4,999 Finnish war veterans who participated in both surveys. The prevalence of self-reported severe pain, walking difficulties, vision, hearing and memory impairment, fatigue and depression increased statistically significantly among veteran men, and all but the prevalence of severe pain among women, when the veterans got older (Table 2).

Table 2. The age-adjusted prevalence of self-reported physical and mental conditions among the 4,999 Finnish war veterans who participated in both the Veteran Project 1992 and 2004 (III, published by permission of Oxford University Press).

Variables	Men without disability (n=2,615)			Men with disability (n=1,733)			Women (n=651)		
	Study year			Study year			Study year		
	1992	2004	P value	1992	2004	P value	1992	2004	P value
Mean age (years)	70.5	82.2		71.5	83.2		70.5	82.3	
Severe pain	4.1	7.5	<0.001	7.0	9.8	0.001	8.3	10.2	0.200
Walking difficulties	17.4	45.8	<0.001	26.1	48.3	<0.001	19.1	48.0	<0.001
Vision impairment	5.6	15.1	<0.001	8.4	15.9	<0.001	8.4	15.7	<0.001
Hearing impairment	5.1	13.9	<0.001	10.9	16.3	<0.001	1.6	5.3	0.002
Memory impairment	2.4	9.7	<0.001	5.1	11.7	<0.001	0.9	6.5	<0.001
Fatigue	10.8	24.7	<0.001	16.1	29.7	<0.001	15.2	25.3	<0.001
Depression	4.3	8.3	<0.001	6.1	9.1	<0.001	6.1	9.6	0.017

Values are percentages

The prevalence of self-reported diseases diagnosed or treated by a doctor during the past year or earlier also increased from 1992 to 2004 among the veterans. The prevalence of self-reported CVD, musculoskeletal and neurological diseases increased among veteran men and the prevalence of CVD and neurological diseases among women (Table 3).

Table 3. The age-adjusted prevalence of self-reported diseases diagnosed or treated by a doctor during the last 12 months or earlier among the 4,999 Finnish war veterans who participated in both the Veteran Project 1992 and 2004 (III, published by permission of Oxford University Press).

Variables	Men without disability (n=2,615)			Men with disability (n=1,733)			Women (n=651)		
	Study year			Study year			Study year		
	1992	2004	P value	1992	2004	P value	1992	2004	P value
Mean age (years)	70.5	82.2		71.5	83.2		70.5	82.3	
Cardiovascular disease ¹	47.3	60.7	<0.001	52.0	63.5	<0.001	54.1	68.2	<0.001
Musculoskeletal disease ²	53.0	50.5	0.038	65.6	61.9	0.010	60.7	57.3	0.132
Neurological disease ³	2.1	6.3	<0.001	2.3	7.5	<0.001	1.4	3.5	0.006

Values are percentages

¹ Cardiovascular diseases cover heart attack, coronary disease, heart failure, and diabetes

² Musculoskeletal diseases cover rheumatoid arthritis, osteoarthritis in the hip, knee or shoulder joint or back, and other back disorders

³ Neurological diseases cover Parkinson's disease and stroke

5.1 Trends in health status among 80–84-year-old Finnish war veterans (Study I)

In 1992, 19,790 men and 4,198 women, and in 2004, 2,304 men and 346 women aged 80–84 years old participated in the Veteran Project 1992 and 2004 surveys (Study I). Their self-reported physical and mental conditions in 1992 and 2004 are presented in Table 4. The proportions of veteran men with or without disability who reported good SRH, painlessness, the ability to walk 500 m without difficulties, normal vision, hearing and memory and no depression significantly increased during the study period. Only the increase in proportions of those with normal hearing among men without disability was not statistically significant. Among women, the proportions of respondents who rated either their vision or memory as normal increased statistically significantly. The proportion of veteran men with disability and good SRH seemed to be lower than that among men without disability or among women, and they also reported more frequent pain in both 1992 and 2004.

Table 4. Self-reported physical and mental conditions among 80–84-year-old Finnish war veterans in 1992 and 2004 (I, published by permission of SAGE).

Variable	Men without disability			Men with disability			Women		
	Study year			Study year			Study year		
	1992	2004	P value	1992	2004	P value	1992	2004	P value
Number of subjects	16,109	1,293		3,681	1,011		4,198	346	
Good self-rated health	20.6	24.0	0.005	13.6	18.4	<0.001	24.2	26.5	0.445
Painlessness	59.2	65.1	<0.001	46.3	52.7	<0.001	55.2	61.5	0.057
No walking difficulties	46.0	53.8	<0.001	37.1	45.6	<0.001	44.7	48.6	0.154
Normal vision	69.0	85.6	<0.001	66.5	84.2	<0.001	68.2	84.5	<0.001
Normal hearing	31.8	34.1	0.098	24.7	28.5	0.019	50.8	55.7	0.138
Normal memory	32.7	42.1	<0.001	26.2	34.2	<0.001	44.7	51.8	0.009
No depression	88.4	91.7	<0.001	86.3	89.7	0.008	89.2	91.5	0.233

Valuables are percentages

Table 5. Self-reported diseases diagnosed or treated by a doctor during the last 12 months or earlier among 80–84-year-old Finnish war veterans in 1992 and 2004 (I, published by permission of SAGE).

Variable	Men without disability			Men with disability			Women		
	Study year			Study year			Study year		
	1992	2004	P value	1992	2004	P value	1992	2004	P value
Number of subjects	16,109	1,293		3,681	1,011		4,198	346	
Hypertension	19.7	40.0	<0.001	21.0	37.7	<0.001	27.5	50.0	<0.001
Diabetes	10.6	13.8	<0.001	12.8	15.5	0.025	12.4	15.9	0.061
Coronary disease	23.7	25.2	0.221	30.8	27.5	0.044	23.8	27.5	0.131
Heart failure	26.3	18.9	<0.001	30.7	21.8	<0.001	31.1	23.1	0.002
Osteoarthritis in hip, knee or shoulder joint	32.6	40.7	<0.001	45.2	50.0	0.007	44.3	44.8	0.860
Osteoarthritis or other back diseases	24.9	26.8	0.140	33.7	33.8	0.920	30.3	33.8	0.175
Severe cognitive impairment	14.8	9.9	<0.001	18.3	11.5	<0.001	9.6	6.1	0.032
Parkinson's disease	3.0	2.5	0.324	3.5	3.6	0.965	1.3	1.5	0.870
Stroke	5.7	3.6	0.002	6.5	5.0	0.085	4.0	2.0	0.062

Values are percentages

Self-reported diseases diagnosed or treated by a doctor during the last 12 months or earlier among the 80–84-year-old Finnish war veterans during 1992 and 2004 are presented in Table 5.

In 2004, the prevalence of diseases reported to have been diagnosed by a doctor during the past year or earlier, such as hypertension, diabetes and osteoarthritis in hip, knee or shoulder joints, was significantly higher among 80–84-year-old men with or without disability than in 1992. Among women, the prevalence of hypertension increased significantly from 1992 to 2004. The prevalence of heart failure and severe cognitive impairment decreased significantly in all groups during the follow-up.

5.2 Self-rated health (Studies I, II and IV)

In the cross-sectional study, veteran men aged 80–84 years rated their health as “good” in 2004 statistically significantly more often than those of the same age in 1992. In 2004, the proportions were 24% among men without disability and 18.4% among men with disability, whereas in 1992 the proportions were 20.6% and 13.6%, respectively. Among women, the increase from 24.2% in 1992 to 26.5% in 2004 was not statistically significant (Table 4).

Among those 4,999 veterans who participated in both the Veteran Project 1992 and 2004 surveys, 89.6% of men without disability, 85.4% of men with disability and 87.8% of women assessed their health compared with others in their age group as moderate or better in 1992. In 2004, when they were 12 years older, the proportions were 83.3%, 77.8% and 83%, respectively (Table 6).

Table 6. Self-rated health among the 4,999 Finnish war veterans who participated in both the Veteran 1992 and 2004 Projects (II, published by permission of Elsevier).

Variable	Men without disability			Men with disability			Women		
	Study year			Study year			Study year		
	1992	2004	P value	1992	2004	P value	1992	2004	P value
Mean age (years)	70.5	82.2		71.5	83.2		70.5	82.3	
Self-rated health									
Very good	4.2	4.5		2.4	2.8		3.4	5.1	
Good	22.8	22.0		16.3	17.6		24.1	22.1	
Moderate	62.6	56.8		66.7	57.4		60.3	55.8	
Rather poor	9.0	11.9		12.4	14.8		10.0	13.4	
Poor	0.0	5.2	<0.001	2.1	7.4	<0.001	2.2	3.5	<0.001

Values are percentages

Table 7a. Self-reported physical and mental conditions and diseases during 1992–2004 by improved/unchanged and declined self-rated health (SRH) among veteran men who participated in both Veteran Projects (II, published by permission of Elsevier).

Variable	Men without disability					Men with disability				
	Improved/ unchanged SRH		Declined SRH		p	Improved/ unchanged SRH		Declined SRH		p
	(n=2,277)		(n=288)			(n=1,547)		(n=162)		
	Study year					Study year				
1992	2004	1992	2004		1992	2004	1992	2004		
Severe walking difficulties	19.4	46.4	3.2	48.1	<0.001	29.2	57.9	5.1	50.0	0.002
Vision impairment	6.5	15.0	2.1	19.6	0.004	10.1	17.1	4.3	21.0	0.038
Memory impairment	3.8	12.0	0.7	14.3	0.031	7.0	16.1	3.8	16.6	0.358
Fatigue	12.0	24.7	2.1	25.2	0.003	17.8	30.7	2.6	25.7	0.130
Cardiovascular disease	49.8	62.0	31.9	55.6	0.005	53.8	63.1	40.1	68.5	0.001
Musculoskeletal disease	55.7	51.9	34.0	43.4	0.006	68.3	62.6	45.7	56.8	<0.001
Neurological disease	2.3	5.9	1.0	10.1	0.002	2.5	7.2	0.6	10.5	0.061

Values are percentages. Veterans with unknown change in SRH are excluded

p= p values for the differences in changes over time between improved/unchanged and declined self-rated health groups

Table 7b. Self-reported physical and mental conditions and diseases during 1992–2004 by improved/unchanged and declined self-rated health (SRH) among women who participated in both Veteran Projects (II, published by permission of Elsevier).

Variable	Improved/unchanged SRH (n=567)		Declined SRH (n=78)		p
	Study year		Study year		
	1992	2004	1992	2004	
Severe walking difficulties	22.0	52.5	1.3	56.2	<0.001
Vision impairment	9.2	15.9	5.1	16.7	0.678
Memory impairment	1.7	8.7	0.0	10.5	0.679
Fatigue	16.8	24.8	4.0	29.7	0.013
Cardiovascular disease	56.6	69.1	35.9	64.1	0.023
Musculoskeletal disease	63.5	58.4	43.6	52.6	0.067
Neurological disease	1.6	2.6	0.0	9.0	<0.001

Values are percentages. Veterans with unknown change in SRH are excluded

p= p values for the differences in changes over time between improved/unchanged and declined self-rated health groups

Self-reported physical and mental conditions and diseases diagnosed by a doctor during the last 12 months or earlier from 1992 to 2004 by improved/unchanged and declined SRH among Finnish war veterans who participated in both of the Veteran 1992 and 2004 Projects are presented in Tables 7a and 7b. During the 12-year follow-up, from 1992 to 2004 among 4,999 veterans (mean age in 2004 82.6 years), SRH improved or remained unchanged among 88.8% of the men without disability, 90.5% of the men with disability and 87.9% of the women. The proportions of severe walking difficulties, vision and memory impairment, fatigue and CVD increased statistically significantly among all veterans, independently of whether their SRH was improved/remained unchanged or declined (p values not shown). The increase of severe walking difficulties and CVD was significantly steeper in veterans who experienced decline in their SRH. The veteran men whose SRH declined during the follow-up had a significantly steeper increase in their proportions of vision impairment and musculoskeletal diseases than veterans without decline. Similarly, men without disability and women had a steeper increase in their proportions of fatigue and neurological diseases, and men without disability had a steeper increase in their proportion of memory impairment than veterans without declined SRH. The proportions of severe pain, hearing impairment and depression were similar among veterans with declined, improved or unchanged SRH (data not shown).

In the multiple logistic regression analyses a new CVD during the follow-up independently predicted a decline in SRH among all veterans and increased walking difficulties significantly among men without disability and among women. The highest estimates for declined SRH were institutionalization among men without disability, a new musculoskeletal disease among men with disability and a new neurological disease among women (Table 8).

Table 8. An age-adjusted multivariate model for determinants of declined self-rated health in 2004 among the 4,999 Finnish war veterans who participated in both the Veteran 1992 and 2004 Projects (II, published by permission of Elsevier).

Variable	Men without disability (n= 288)	Men with disability (n= 162)	Women (n=78)
Widowed or divorced	0.77 (0.52–1.15)	0.79 (0.47–1.35)	0.89 (0.43–1.84)
Increased pain	0.74 (0.40–1.38)	0.82 (0.38–1.79)	1.18 (0.45–3.10)
Increased walking difficulties	1.52 (1.12–2.08)	1.45 (0.97–2.17)	1.98 (1.08–3.64)
Impaired vision	1.32 (0.89–1.97)	1.66 (1.00–2.76)	0.85 (0.34–2.13)
Impaired hearing	0.72 (0.45–1.17)	0.85 (0.46–1.59)	1.17 (0.32–4.27)
Impaired memory	1.06 (0.67–1.69)	0.92 (0.51–1.69)	0.99 (0.32–3.01)
Increased fatigue	1.14 (0.79–1.65)	1.01 (0.62–1.64)	1.45 (0.72–2.93)
Onset of depression	0.96 (0.53–1.76)	0.44 (0.17–1.13)	0.79 (0.25–2.49)
New cardiovascular disease	1.50 (1.09–2.06)	1.80 (1.19–2.72)	2.16 (1.15–4.04)
New musculoskeletal disease	1.35 (0.96–1.90)	2.19 (1.42–3.36)	1.67 (0.81–3.43)
New neurological disease	1.93 (1.16–3.20)	1.84 (0.93–3.65)	3.44 (0.96–12.33)
Entered institutional care	3.03 (1.50–6.14)	0.89 (0.30–2.68)	0.87 (0.21–3.59)

Values are Odds ratios (OR) with 95% Confidence Intervals (CI). ORs are given for dichotomous yes/no variables

SRH was found to predict total mortality independently among men without disability (HR 1.14; 95% CI 1.12–1.16) and among women (HR 1.14; 95% CI 1.11–1.17). Absolute 10-year risks for total mortality among veterans with impaired SRH were 0.455 among men without disability and 0.263 among women. Impaired SRH alone was not an explanatory variable for total mortality among men with disability. The absolute 10-year mortality risks among veterans with impaired SRH and another risk factor (walking difficulties, multimorbidity, fatigue, urinary incontinence, living alone or depression) are shown in Table 9.

Table 9. Absolute 10-year mortality risks for total mortality among Finnish war veterans with impaired self-rated health and another risk factor in 1992 (IV, published by permission of John Wiley and Sons).

Variable	Men without disability (n=129,587)	Men with disability (n=33,638)	Women (n=48,710)
Impaired self-rated health	0.455		0.263
and walking difficulties	0.652	0.602	0.389
or multimorbidity ¹	0.575	0.553	0.376
or fatigue	0.516	0.479	0.290
or urinary incontinence	0.510	0.478	
or living alone	0.498		0.263
or depression		0.463	0.296

Veterans who died before November 23 1992 (n=304) are excluded

Absolute 10-year mortality risk is calculated for men and women aged 73.5 years at baseline

Self-rated health alone was not an explanatory variable for total mortality among men with disability

¹ Multimorbidity covers at least 3 of the following diseases: coronary heart disease, heart failure, lung disease (asthma, chronic obstructive pulmonary disease or emphysema), fracture, Parkinson's disease, stroke or cancer

5.3 Functional capacity (Study III)

Veterans' ability to perform activities of daily living in 2004 were asked of those 4,999 veterans who participated in both surveys. The result was that 54.3% of men without disability, 43.0% of men with disability and 52.2% of women were independent in all BADL. The proportions of those independent in IADL were 40.1%, 26.1% and 39.6%, respectively (data not shown). As expected, the proportions of veterans who were able to perform IADL tasks were lower than those able to perform BADL tasks.

In the multivariate logistic regression analysis, the presence in 1992 of a neurological disease among men without disability, walking difficulties among men with disability and a musculoskeletal disease among women had the highest risk estimates for impaired BADL in 2004. Walking difficulties in 1992 had the highest risk estimates for impaired IADL in 2004 among all groups (Tables 10a and 10b).

Table 10a. An age-adjusted multivariate model for self-reported physical and mental conditions in 1992 as predictors for declined basic (BADL) and instrumental (IADL) activities of daily living among veteran men in 2004 (III, published by permission of Oxford University Press).

Variable	Men without disability (n=2,615)		Men with disability (n=1,733)	
	Impaired BADL	Impaired IADL	Impaired BADL	Impaired IADL
Severe pain	1.35 (0.81–2.27)	0.90 (0.51–1.60)	2.03 (1.18–3.49)	2.54 (1.18–5.49)
Walking difficulties	2.07 (1.58–2.70)	2.82 (2.04–3.89)	2.41 (1.79–3.25)	3.33 (2.25–4.93)
Vision impairment	2.08 (1.35–3.22)	2.10 (1.24–3.56)	1.77 (1.12–2.80)	1.54 (0.87–2.71)
Hearing impairment	1.61 (1.04–2.50)	2.08 (1.21–3.57)	1.44 (0.99–2.10)	1.44 (0.91–2.28)
Memory impairment	1.25 (0.63–2.47)	1.58 (0.71–3.53)	1.63 (0.90–2.95)	1.25 (0.62–2.51)
Fatigue	1.69 (1.20–2.37)	2.35 (1.53–3.57)	1.47 (1.01–2.12)	1.65 (1.01–2.69)
Depression	1.73 (1.04–2.86)	1.53 (0.87–1.69)	1.51 (0.85–2.67)	2.53 (1.03–6.20)
Cardiovascular disease	1.40 (1.16–1.69)	1.33 (1.09–1.61)	1.26 (1.00–1.59)	1.25 (0.96–1.62)
Musculoskeletal disease	1.24 (1.03–1.49)	1.44 (1.19–1.75)	1.31 (1.03–1.68)	1.35 (1.03–1.77)
Neurological disease	5.78 (2.49–13.43)	2.34 (1.02–5.38)	2.16 (0.83–5.60)	1.05 (0.37–2.99)

Values are Odds ratios (with 95% confidence intervals)

ORs are given for dichotomous (yes/no) variables

Table 10b. An age-adjusted multivariate model for self-reported physical and mental conditions in 1992 as predictors for declined basic (BADL) and instrumental (IADL) activities of daily living among women (n=651) in 2004 (III, published by permission of Oxford University Press).

Variable	Impaired BADL	Impaired IADL
Severe pain	1.06 (0.47–2.40)	1.38 (0.52–3.65)
Walking difficulties	2.21 (1.27–3.84)	3.64 (1.84–7.23)
Vision impairment	2.08 (0.97–4.46)	1.54 (0.68–3.46)
Hearing impairment	1.66 (0.24–11.58)	1.79 (0.18–18.32)
Memory impairment	0.54 (0.03–9.05)	NA
Fatigue	1.58 (0.81–3.04)	3.48 (1.55–7.84)
Depression	1.45 (0.93–6.47)	1.30 (0.43–3.96)
Cardiovascular disease	1.07 (0.71–1.59)	1.17 (0.78–1.76)
Musculoskeletal disease	2.39 (1.58–3.62)	1.67 (1.11–2.51)
Neurological disease	2.37 (0.26–21.53)	NA

Values are Odds ratios (with 95% confidence intervals).

ORs are given for dichotomous (yes/no) variables

NA= Number of cases is too low to calculate

In the logistic regression analyses (Table 11a and 11b), after adjusting for age and each baseline variable (severe pain, walking difficulties, vision, hearing and memory impairment, fatigue, depression, CVD and musculoskeletal and neurological disease), the significant ORs varied from 1.8 to 9.9 for the associations between impaired BADL in 2004 and impaired vision, hearing and memory, increased pain, walking difficulties and fatigue and onset of depression or a new neurological disease from 1992 to 2004 among men with and without disability. Among men without disability, the risk of impaired BADL was also associated significantly with a new musculoskeletal disease. Among women, the significant ORs between impaired BADL were the same as those among men, only the OR associated with impaired hearing was not significant. The highest risk estimates for IADL were for memory impairment among all groups.

In the multivariate model (adjusted for age, increased pain, fatigue and walking difficulties, impaired vision, hearing and memory, onset of depression, new cardiovascular, musculoskeletal and neurological disease), the associations remained similar to those in Tables 11a and 11b. However, the risk of impaired IADL in men with disability and the risk of impaired BADL in women associated with a new neurological disease, as well as the risk of impaired BADL associated with impaired hearing in men with disability and impaired vision in women were no longer significant (data not shown).

Table 11a. Odds ratios (OR) with 95% Confidence Intervals (CI) for changes in self-reported physical and mental conditions during 1992–2004 and their associations with impaired basic (BADL) and instrumental (IADL) activities of daily living among veteran men (III, published by permission of Oxford University Press).

Variable	Men without disability (n=2,615)		Men with disability (n=1,733)	
	Impaired BADL	Impaired IADL	Impaired BADL	Impaired IADL
Age	1.11 (1.09–1.14)	1.14 (1.11–1.17)	1.11 (1.07–1.14)	1.14 (1.10–1.19)
Increased pain	5.92 (3.82–9.17)	7.71 (4.31–13.80)	3.66 (2.24–5.98)	6.15 (2.82–13.40)
Increased walking difficulties	4.15 (3.43–5.01)	5.87 (4.67–7.37)	2.50 (1.99–3.14)	3.38 (2.52–4.54)
Impaired vision	4.52 (3.40–6.02)	7.63 (5.09–11.42)	4.23 (2.91–6.15)	7.38 (3.96–13.75)
Impaired hearing	1.94 (1.47–2.57)	3.24 (2.67–4.62)	1.80 (1.26–2.55)	3.05 (1.83–5.08)
Impaired memory	4.57 (3.29–6.34)	7.93 (4.88–12.88)	3.95 (2.60–5.99)	10.07 (4.40–23.02)
Increased fatigue	3.73 (2.96–4.70)	6.43 (4.69–8.82)	3.32 (2.48–4.46)	4.49 (2.98–6.79)
Onset of depression	4.74 (3.07–7.32)	7.01 (3.81–12.90)	4.25 (2.48–7.27)	5.40 (2.47–11.82)
New cardiovascular disease	0.87 (0.72–1.06)	1.00 (0.81–1.22)	0.92 (0.72–1.17)	1.01 (0.77–1.33)
New musculoskeletal disease	1.46 (1.18–1.80)	1.17 (0.93–1.46)	0.94(0.72–1.24)	0.99 (0.72–1.35)
New neurological disease	9.89 (5.88–16.66)	7.45 (4.15–13.39)	3.70 (2.24–6.12)	3.31 (1.74–6.30)

Adjusted for age and for each baseline variable

Values are Odds ratios (with 95% confidence intervals). ORs are given for dichotomous (yes/no) variables

Table 11b. Odds ratios (OR) with 95% Confidence Intervals (CI) for changes in self-reported physical and mental conditions during 1992–2004 and their associations with impaired basic (BADL) and instrumental (IADL) activities of daily living among women (n=651) (III, published by permission of Oxford University Press).

Variable	Impaired BADL	Impaired IADL
Age	1.12 (1.07–1.18)	1.16 (1.10–1.22)
Increased pain	3.67 (1.79–7.52)	5.16 (2.11–12.60)
Increased walking difficulties	2.95 (2.06–4.24)	5.11 (3.37–7.76)
Impaired vision	2.14 (1.27–3.63)	3.55 (1.83–6.87)
Impaired hearing	2.29 (0.98–5.37)	NA
Impaired memory	8.98 (3.44–23.42)	26.72 (3.61–197.96)
Increased fatigue	6.47 (3.75–11.18)	4.41 (2.50–7.78)
Onset of depression	2.59 (1.23–5.44)	2.83 (1.19–6.73)
New cardiovascular disease	1.15 (0.77–1.71)	1.17 (0.77–1.76)
New musculoskeletal disease	0.78 (0.49–1.26)	0.76 (0.47–1.21)

Adjusted for age and for each baseline variable. NA= Number of cases is too low to calculate

Values are Odds ratios (with 95% confidence intervals). ORs are given for dichotomous (yes/no) variables

5.4 Walking difficulties (Studies I– IV)

As expected, walking difficulties increased significantly among all veteran groups during the follow-up as the veterans became older (Table 2). Among the 80–84-year-old veterans, 46.0% of men without disability, 37.1% of men with disability and 44.7% of women reported the ability to walk 500 m without difficulty in 1992. In 2004, these proportions among the veterans of that age were 53.8%, 45.6% and 48.6%, respectively. The increase in the proportions of those who were able to walk 500 m was statistically significant among men (Table 4).

Determinants of ability to walk 500 m without difficulties among the 80–84-year-old Finnish war veterans in 2004 are presented in Table 12.

Table 12. Multivariate model for determinants of ability to walk 500 m without difficulties among 80–84-year-old Finnish war veterans in 2004. Odds ratios (OR) with 95% Confidence Intervals (CI) (I, published by permission of SAGE).

Variable	Men without disability (n=1,293)	Men with disability (n=1,011)	Women (n=346)
Good self-rated health	3.44 (2.30–5.13)	3.33 (2.15–5.14)	3.75 (1.83–7.70)
Painlessness	1.80 (1.32–2.45)	2.32 (1.66–3.25)	1.94 (1.05–3.58)
Heart disease	0.30 (0.19–0.49)	0.25 (0.15–0.41)	0.19 (0.07–0.48)
Rheumatoid arthritis or osteoarthritis	0.75 (0.55–1.02)	0.71 (0.50–1.02)	0.74 (0.40–1.38)
Depression	0.46 (0.26–0.81)	0.52 (0.29–0.94)	0.42 (0.16–1.15)
Fatigue	0.29 (0.20–0.42)	0.37 (0.25–0.55)	0.12 (0.05–0.32)
Hospital care during the last 12 months	0.34 (0.25–0.46)	0.66 (0.47–0.92)	0.50 (0.26–0.95)
Rehabilitation in a rehabilitation facility	0.98 (0.68–1.43)	1.80 (0.95–3.42)	1.87 (0.88–4.01)
Rehabilitation in an outpatient clinic	1.00 (0.74–1.34)	0.92 (0.65–1.31)	1.39 (0.77–2.51)

Values are Odds ratios (with 95% confidence intervals). Odds ratios are given for dichotomous (yes/no) variables

Variables are adjusted for good self-rated health, painlessness, heart disease, rheumatoid arthritis or osteoarthritis, depression, fatigue, hospital care during the last 12 months and rehabilitation in a rehabilitation facility or in an outpatient clinic

The ability to walk 500 m outdoors without difficulties was associated with painlessness among all veteran groups. The presence of heart diseases and fatigue and hospital care were associated with a decreased ability to walk 500 m without difficulties among all veterans, as well as the presence of depression among veteran men. Participation in rehabilitation programs, however, was not associated with the ability to walk 500 m without difficulties. Among the 80–84-year-old veterans, the ability to walk 500 m outdoors without difficulties was associated with good SRH among all veteran groups. Among the 4,999 war veterans who participated in both surveys, an increase in walking difficulties between 1992 and 2004 was independently and significantly associated with a decline in SRH among men without disability (OR 1.52; 95% CI 1.12–2.08) and among women (OR 1.98; 95% CI 1.08–3.64) (Table 8). Among the veterans who experienced decline in their SRH during 1992 to 2004, the increase in the proportions of severe walking difficulties was significantly steeper than among veterans with improved or unchanged SRH (Tables 7a and 7b).

Walking difficulties in 1992 were significantly associated with both impaired BADL and IADL in 2004 among all veteran groups, with ORs varying between 2.07–3.64 (Tables 10a and 10b). Also, an increase in walking difficulties during the follow-up was associated with both impaired BADL and IADL in 2004 among all veteran groups (Tables 11a and 11b).

In an average 9.9-year follow-up, walking difficulties were found to be the strongest predictor for total mortality among all veteran groups: HR 1.74 (95% CI 1.71–1.76) among men without disability, HR 1.62 (95% CI 1.58–1.67) among men with disability and HR 1.61 (95% CI 1.57–1.65) among women. The highest adjusted HRs of CVD mortality were also for walking difficulties among men without disability (HR 1.98; 95% CI 1.95–2.02) and among men with disability (HR 1.88; 95% CI 1.82–1.94) (Table 14). The highest absolute single risk for total mortality among veterans was walking difficulties: 0.605 among men without disability, 0.602 among men with disability, and 0.351 among women (Table 13). A combination of walking difficulties and multimorbidity had the highest absolute risk for total mortality (0.730 among men without disability, 0.729 among men with disability and 0.487 among women) (Table 15) and for CVD mortality (0.665, 0.696, and 0.417, respectively, data not shown). If a veteran had three risk factors (data not shown), the highest risk of dying was among those with walking difficulties, multimorbidity and fatigue combined among men (0.790 among men without disability and 0.777 among men with disability) and with walking difficulties, multimorbidity and depression combined among women (0.536).

Table 13. Absolute 10-year mortality risks for total mortality among Finnish war veterans with walking difficulties and with another risk factor in 1992 (IV, by permission of John Wiley and Sons).

Variable	Men without disability (n=129,587)	Men with disability (n=33,638)	Women (n=48,710)
Walking difficulties	0.605	0.602	0.351
and living alone	0.651	0.640	0.351
or impaired self-rated health	0.652	0.602	0.389
or urinary incontinence	0.664	0.651	0.351
or fatigue	0.670	0.653	0.384
or multimorbidity ¹	0.730	0.729	0.487
or depression		0.635	0.391

Veterans who died before November 23 1992 (n=304) are excluded

Absolute 10-year mortality risk is calculated for men and women aged 73.5 years at baseline

¹ Multimorbidity covers at least 3 of the following diseases: coronary heart disease, heart failure, lung disease (asthma, chronic obstructive pulmonary disease or emphysema), fracture, Parkinson's disease, stroke or cancer

5.5 Predictors of late-life mortality among Finnish war veterans (Study IV)

In the prospective follow-up study, the main outcomes were total, CVD and AAV mortality. CVD was the most common cause of death among all veteran groups. Of men without disability, 80.9% died during an average 9.9-year follow-up compared to 82.3% of men with disability and 63.6% of women. In the same groups, mortality rates per 100 person-years were 8.74, 8.84, and 5.29, respectively.

Increasing age, walking difficulties, fatigue and multimorbidity at baseline were found to predict total mortality independently among all veteran groups, with HRs varying from 1.09–1.74 (Table 14). The strongest predictor of total mortality was walking difficulties among all veteran groups. For total mortality, impaired SRH at baseline showed a 1.14-fold risk among both men without disability and women, the presence of depression at baseline showed a significant 1.10-fold risk among men with disability and 1.15-fold risk among women. Among men with urinary incontinence, the significant HRs for total mortality varied from 1.15 to 1.16 and among those living alone from 1.11 to 1.13.

Table 14. Adjusted Hazard ratios (HR) with 95% Confidence intervals (CI) for total, cardiovascular disease and accidents and violence mortality among Finnish war veterans (IV, by permission of John Wiley and Sons).

Variables	Men without disability (n=129,587)	Men with disability (n=33,638)	Women (n=48,710)
Total mortality			
No risk factors	1.00	1.00	1.00
Age at baseline	1.09 (1.09–1.09)	1.09 (1.09–1.09)	1.13 (1.12–1.13)
Impaired self-rated health	1.14 (1.12–1.16)		1.14 (1.11–1.17)
Walking difficulties	1.74 (1.71–1.76)	1.62 (1.58–1.67)	1.61 (1.57–1.65)
Fatigue	1.20 (1.18–1.21)	1.15 (1.11–1.18)	1.12 (1.09–1.16)
Depression		1.10 (1.05–1.14)	1.15 (1.11–1.20)
Urinary incontinence	1.18 (1.15–1.20)	1.15 (1.11–1.19)	
Multimorbidity ¹	1.41 (1.38–1.44)	1.42 (1.37–1.47)	1.54 (1.48–1.61)
Living alone	1.13 (1.12–1.15)	1.11 (1.08–1.14)	
Cardiovascular disease mortality			
No risk factors	1.00	1.00	1.00
Age at baseline	1.09 (1.09–1.10)	1.10 (1.09–1.10)	1.13 (1.13–1.14)
Impaired self-rated health	1.21 (1.19–1.24)		1.22 (1.18–1.27)
Walking difficulties	1.98 (1.95–2.02)	1.88 (1.82–1.94)	1.81 (1.75–1.86)
Multimorbidity ¹	1.72 (1.68–1.76)	1.69 (1.62–1.76)	1.87 (1.79–1.96)
Living alone	1.14 (1.12–1.16)		
Accidents and violence mortality			
No risk factors	1.00	1.00	1.00
Age at baseline	1.11 (1.11–1.12)	1.12 (1.10–1.13)	1.16 (1.15–1.17)
Falls	1.88 (1.69–2.09)	1.94 (1.65–2.28)	
Impaired memory	1.59 (1.46–1.74)		
Urinary incontinence		1.47 (1.30–1.67)	
Living alone	1.31 (1.24–1.39)		

Veterans who died before November 23 1992 (n=304) are excluded

Values are Hazard ratios (with 95% confidence intervals)

¹ Multimorbidity covers at least 3 of the following diseases: coronary heart disease, heart failure, lung disease (asthma, chronic obstructive pulmonary disease or emphysema), fracture, Parkinson's disease, stroke or cancer

The highest adjusted HRs of CVD mortality were also for walking difficulties: HR 1.98 (95% CI 1.95–2.02) among men without disability and HR 1.88 (95% CI 1.82–1.94) among men with disability. Among women, the highest HR of CVD mortality was for multimorbidity (HR 1.87; 95% CI 1.79–1.96). For AAV mortality, the highest HRs among men were for falls: HR 1.88 (95% CI 1.69–2.09) among men without disability and HR 1.94 (95% CI 1.65–2.28) among men with

disability. Increasing age was the only significant risk factor for AAV mortality among women.

Absolute 10-year mortality risks for total mortality among Finnish war veterans are shown in Table 9 for impaired SRH, in Table 13 for walking difficulties and in Table 15 for multimorbidity.

Table 15. Absolute 10-year mortality risks for total mortality among Finnish war veterans with multimorbidity and another risk factor (IV, by permission of John Wiley and Sons).

Variable	Men without disability (n=129,587)	Men with disability (n=33,638)	Women (n=48,710)
Multimorbidity ¹	0.529	0.553	0.339
and living alone	0.574	0.590	0.339
or impaired self-rated health	0.575	0.553	0.376
or urinary incontinence	0.588	0.602	0.339
or fatigue	0.594	0.603	0.372
or walking difficulties	0.730	0.729	0.487
or depression		0.586	0.379

Veterans who died before November 23 1992 (n=304) are excluded

Absolute 10-year mortality risk is calculated for men and women aged 73.5 years at baseline

¹ Multimorbidity covers at least 3 of the following diseases: coronary heart disease, heart failure, lung disease (asthma, chronic obstructive pulmonary disease or emphysema), fracture, Parkinson's disease, stroke or cancer

For those with no risk factors at the baseline, the absolute mortality risk for total mortality was 0.414 among men without disability, 0.433 among men with disability, and 0.236 among women during the 9.9-year follow-up. Walking difficulties alone or together with multimorbidity and/or with a third risk factor represented the most important risk factor for total mortality and for CVD mortality among all veteran groups.

6 Discussion

War experiences have an impact on veterans' whole lifespan (Hunt & Robbins 2001, Nivala & Sarvimaki 2015). Second World War veterans have reported psychological distress even 50 years after the end of the war, and those who had a war-related physical illness or disability have been shown to experience greater distress (Hunt & Robbins 2001). Former Second World War prisoners with PTSD have been found to have increased risks of cardiovascular diseases including hypertension and chronic ischemic heart disease (Kang *et al.* 2006). War time stressors, especially being seriously wounded or having permanent disability or illness, and combat experiences have been observed to predict late-life mortality among Second World veterans (Bramsen *et al.* 2007, Elder *et al.* 1997, Kunnas *et al.* 2011).

The present study explored Finnish Second World War veterans' health status, self-reported determinants of SRH and functional capacity and predictors of mortality. As far as we know, this is the largest study ever carried out among Second World War veterans.

6.1 Assessment of the study population

The present thesis is based on the Veteran 1992 Project and the Veteran 2004 Project surveys. The Veteran 1992 Project survey was conducted with the entire cohort of Finnish war veterans living in Finland ($n=242,720$), and the follow-up survey in 2004, with a randomized sample of 5,750 veterans who participated in the Veteran 1992 Project. The total number of participants in the baseline survey was 177,989 men and 48,745 women, and in the follow-up survey, 4,348 men and 651 women. The response rate was high in both surveys: 93% in 1992 and 87% in 2004, which indicates high external validity of the findings. In 1992, the number of Finnish men aged 65 or over was 250,906 (Statistics Finland 2015), and 76% of them were war veterans.

In this thesis, all analyses were conducted separately for men without disability, men with disability and women. In 1992, the mean age for veteran men without disability was 73.6 years, for men with disability 73.7 years and for women 72.7 years. In 2004, the mean ages were 82.2, 83.2 and 82.3, respectively. Of men without disability, 80.9% died during an average 9.9-year follow-up compared to 82.3% of men with disability and 63.6% of women. In the same groups, mortality rates per 100 person-years were 8.74, 8.84, and 5.29.

6.2 Trends in health status among 80–84-year-old veterans

In our study, the proportions of veterans who reported impairment in physical and mental conditions increased from 1992 to 2004 when the veterans got older, but an improvement in those conditions was found among veterans aged 80–84 years old in 2004 compared with those at the same age in 1992. This is in agreement with previous studies, where health among the older population has been shown to have improved during recent decades, although the prevalence of most diseases has increased in the older population (Martin *et al.* 2007, Zunzunegui *et al.* 2006).

Among men aged 80–84 years, the prevalence of self-reported hypertension, diabetes, osteoarthritis in hip, knee or shoulder joints and prostate hyperplasia were significantly higher in 2004 than in 1992. Among women, the prevalence of hypertension significantly increased from 1992 to 2004. This may in part reflect improved diagnostic practices, but it is possible that the veterans' own attitudes have changed and they see their doctor more often than before. During the study period, the blood pressure threshold for the diagnosis of hypertension in the elderly was lowered, which partly explains the higher prevalence of hypertension among veterans in 2004. The average body weight of the Finnish population has increased during recent decades (Borodulin *et al.* 2014), and obesity is a well-known risk factor for diabetes, hypertension and osteoarthritis of the weight-bearing joints. The occurrence of reported heart failure increased among all veterans with increasing age. However, it decreased in comparison to the 80–84-year-old veterans' subgroup from 1992 to 2004, indicating that heart diseases manifest clinically at an older age than before (Kattainen *et al.* 2002). This may also reflect the decrease in several major cardiovascular risk factors in middle-aged Finnish people during recent decades (Aromaa & Koskinen 2004, Di Cesare *et al.* 2013, Vartiainen *et al.* 2000), as well as the more effective treatment of raised blood pressure and CHD and the increased use of cardioprotective drugs (Kotseva *et al.* 2009).

The prevalence of memory impairment increased as expected with aging. On the other hand, the 80–84-year-old veterans in our study reported normal self-rated memory more often in 2004 than in 1992 and, according to the veterans' answers, their doctors also diagnosed severe cognitive impairment less frequently in 2004 than in 1992. This is surprising, as knowledge about the symptoms of dementia has increased among the population and new drugs have been

developed for the treatment of dementia during the last decades. Dementia shares the same vascular risk factors with cardiovascular diseases (Kivipelto *et al.* 2006), and it is possible that the onset of dementia is postponed until older ages, similarly to the observation for cardiovascular diseases in the Finnish population (Lehtonen *et al.* 2004, Salomaa *et al.* 2003).

6.3 Self-rated health as the determinant of morbidity and mortality

It is suggested that adaptation to deteriorating health plays an important role in older people's health assessments (Idler 1993). In previous studies, war veterans of the oldest old have been shown to have poorer health than non-veterans (Liu *et al.* 2006, Wilmoth *et al.* 2010). In the present study, the majority of those 4,999 veterans who participated in both surveys rated their health as improved or unchanged during the 12-year follow-up, although the prevalence of most diseases increased during the follow-up. Also the proportion of 80–84-year-old veterans who rated their health very good or good was higher in 2004 than in 1992.

SRH levels have been thought to reflect the underlying disease burden (Guccione *et al.* 1994, Hillen *et al.* 2003, Kaplan *et al.* 1996, Weisen *et al.* 1999). In our study, declined SRH was associated with a new CVD among all veteran groups, with a new neurological disease among men without disability and with a new musculoskeletal disease among men with disability. This is in agreement with the findings from the Evergreen project, where declined SRH over a 5-year period was related to an increased number of chronic conditions (Leinonen *et al.* 2001).

Chronic disorders such as memory, vision and hearing impairment (Campbell *et al.* 2008, Jacobs *et al.* 2005, Maggi *et al.* 1998), fatigue (Moreh *et al.* 2010), depression (Han 2002, Millan-Calenti *et al.* 2012, Mulsant *et al.* 1997) and pain (Mantyselka *et al.* 2003, Molarius & Janson 2002, Reyes-Gibby *et al.* 2002) have been found to contribute to poor health. However, in our study, only impaired vision among veteran men with disability was related significantly to declined SRH.

In the present study, impaired SRH was a predictor of total and CVD mortality among men without disability and among women, but surprisingly not among veteran men with disability. Impaired SRH has been found to be a strong predictor of mortality, even after adjustment for key covariates such as functional status, depression and comorbidity (DeSalvo *et al.* 2006, Idler & Benyamini

1997). It has been suggested that the advantage of global self-ratings in predicting mortality is partly due to the limitations in the health variables that empirical studies can include, and partly to people's ability to use the sensations of their bodies in self-ratings of health (Jylha 2009). An age-adjusted association has been found between the level of SRH and total and CVD mortality (Giltay *et al.* 2012, Kaplan *et al.* 1996).

6.4 Functional capacity

Functional limitations have been shown to increase with age (Berlau *et al.* 2012, Grundy & Glaser 2000, McGee *et al.* 1998, Tas *et al.* 2011). Fries generated the idea of "the compression of morbidity," where the period of senescence has been thought to be compressed near the end of life (Fries 1980). In our study, 54.3% of men without disability, 43.0% of men with disability and 52.2% of women reported to be independent in all BADL in 2004. IADL is a more sensitive predictor of functional decline than BADL, and its limitations typically develop before those of BADL (Judge *et al.* 1996, McGuire *et al.* 2006). Also in the present study, fewer people were able to perform IADL tasks than BADL tasks; 40.1% of men without disability, 26.1% of men with disability and 39.6% of women were independent in all IADL in 2004. The higher prevalence of disability in women has been thought to be explained by the longer duration of disability due to women's longer survival from the onset of disability (McGee *et al.* 1998, Oman *et al.* 1999).

Chronic conditions and diseases can result in compensatory strategies in performing a task (Nikolova *et al.* 2011). In the present study, a new neurological disease was associated with impaired BADL and IADL, which is in agreement with previous studies (Ali *et al.* 2009, Rost *et al.* 2008). A new CVD had no association with impaired ADL, even though the prevalence of the diseases increased among veterans during 1992–2004, indicating that living with CVD appears to be less disabling now than in the past.

In our study, the onset of memory impairment during 1992–2004 was significantly associated with impaired IADL and BADL. Previously, cognitive and functional decline have been shown to influence each other's development (Black & Rush 2002). An association has also been found between functional impairment and depression (Fichter *et al.* 2008, Kivela & Pahkala 2001, Penninx *et al.* 1998, Weinberger *et al.* 2009), pain (Leveille *et al.* 1999, Shega *et al.* 2010, Soldato *et al.* 2007) and fatigue (Avlund *et al.* 2002, Hardy & Studenski 2008a).

In our study, being depressed in 1992 significantly predicted impaired BADL in men without disability and impaired IADL in men with disability, and the onset of depression during the follow-up was a significant predictor of impaired BADL and IADL among all veteran groups. Increased pain and fatigue were associated independently with BADL and IADL limitations. Vision impairment at baseline appears to have a greater impact on ADL than hearing impairment (Wallhagen *et al.* 2001), which was also stated in our study.

6.5 Walking difficulties as the predictor of impaired SRH, functional capacity and mortality

In our study, the prevalence of walking difficulties increased among all veteran groups as the veterans aged. However, veterans who were 80–84 years old in 2004 complained about walking difficulties less frequently than veterans who were 80–84 years old in 1992. This is in an agreement with the findings from the Health Behaviour and Health among Finnish Elderly Survey (Helldán & Helakorpi 2014) and the Health 2000 Health Examination Survey (Aromaa & Koskinen 2004), large population-based surveys, both organized by the National Institute for Health and Welfare in Finland. According to these surveys, the proportion of those aged 65 or over who can walk outdoors without difficulties has improved during the last decades.

In the present study, increased walking difficulties were an independent determinant of declined SRH among veteran men without disability and women. In previous studies, perceived inability to go out alone, difficulties in walking (Sun *et al.* 2007, Wang *et al.* 2006) and increasing severity of walking difficulties have been shown to have a negative impact on SRH (Crimmins 2004, Gama *et al.* 2000, Hoeymans *et al.* 1997, Jylha *et al.* 2001, Sun *et al.* 2007, Wang *et al.* 2006).

Among non-disabled older persons, objective measures of lower extremity function and the ability to walk 0.25 miles have been found to predict subsequent functional capacity (Fried *et al.* 2000, Fried *et al.* 2001b, Stuck *et al.* 1999). In our study, walking difficulties in 1992 predicted BADL and IADL impairment, and increased walking difficulties during the follow-up were associated with impaired BADL and IADL in all veteran groups.

In the present study, walking difficulties was the most important predictor of total mortality among all veteran groups and of CVD mortality among veteran men. Walking difficulties remained the strongest predictor of total mortality after

excluding veterans who were not able to walk (this group may include demented and seriously ill bedridden patients) or those who had to rest while walking.

Among veterans with two or three risk factors, those with walking difficulties had the highest total absolute mortality risk. This finding is in accordance with previous studies, which found that self-reported mobility disability results in diminished survival (Hirvensalo *et al.* 2000, Khokhar *et al.* 2001). Self-reported ability to walk 0.25 mile has been found to be a powerful predictor of mortality even after adjusting for usual health and demographic indicators (Hardy *et al.* 2011). Of those who completed 400 m of walking, each additional minute of performance time has been found to be associated with higher mortality (Newman *et al.* 2006).

Lower gait speed has been identified to predict a high risk of death among older people (Abellan van Kan *et al.* 2009, Bell *et al.* 2014, Cesari *et al.* 2005), and tiredness in mobility has been shown to be an independent predictor of mortality during the next 10 years (Avlund *et al.* 1998).

6.6 Mortality

In order to provide appropriate care for elderly people, the ability to recognize factors associated with poor survival is essential. While some attempts have been made to create models to predict mortality, most have only been modestly accurate (Siontis *et al.* 2011, Yourman *et al.* 2012). CVD was the most common cause of death among all veteran groups. Absolute risks for total, CVD and AAV mortality without self-reported risk factors were highest among veteran men with disability. It has been shown previously that physical or psychological trauma during young adulthood may lead to lifelong effects on health and increased CHD mortality in late adulthood (Kunnas *et al.* 2011, Page & Brass 2001).

Kane *et al.* showed that seven geriatric syndromes (multiple comorbidities, cognitive impairment, frailty, disability, malnutrition, impaired homeostasis, and chronic inflammation) are associated with poor survival (Kane *et al.* 2012). Multimorbidity is highly prevalent among the elderly and has been found to explain a large proportion of excess mortality among both genders (Menotti *et al.* 2001b, Tooth *et al.* 2008). In the present study, multimorbidity was a predictor of total mortality among all veteran groups and, together with walking difficulties, the strongest predictor of total mortality among veterans with two risk factors.

Depressive syndromes have been found to increase the risk of death in both genders, with the severity and chronicity of depression being associated with a

higher mortality risk (Pulska *et al.* 1999, Schoevers *et al.* 2009). In our study, depression predicted total mortality among men with disability and women, perhaps due to traumatic war experiences and post-traumatic stress reaction. The presence of vision and hearing impairment have been shown to increase the risk of mortality (Cacciatore *et al.* 2004, Feeny *et al.* 2012, Gopinath *et al.* 2013), although sensory impairments were not associated with mortality in the present study. This finding could be partly due to veteran interventions, during which the use of hearing and vision aids became more common.

The mortality rate among the geriatric population with trauma has been found to be higher than among the adult trauma population (Hashmi *et al.* 2014). In the present study, apart from the risk associated with living alone, AAV mortality had different risk factors than total and CVD mortality. Urinary incontinence was a predictor of AAV mortality, which can probably be explained by frailty (Holroyd-Leduc *et al.* 2004). Falls predicted AAV mortality among men significantly, as did impaired memory among men without disability. Elderly people living alone have been found to have higher mortality from accidents than married people due to poor health habits, especially excessive alcohol use, and lack of social support and control (Koskinen *et al.* 2007). Cognitive impairment, even in the absence of manifest dementia, has been shown to be an important independent predictor of mortality, especially among men (Perna *et al.* 2014), and the risk of mortality has been shown to rise with increased severity of cognitive impairment (Sachs *et al.* 2011). In our study, self-reported impaired memory was associated with AAV mortality among men without disability only, although men with disability more commonly reported memory problems.

6.7 Discussion of the methods

In Study I, the study setting was cross-sectional. In this study, trends in health status among 80–84-year old Finnish war veterans were observed in 1992 and 2004. The cross-sectional study design allows the comparison of many different variables at the same time, but it does not provide definitive information about temporal cause-and-effect relationships.

Studies II–IV were longitudinal cohort studies. Unlike cross-sectional studies, cohort studies can reveal temporal relationships between exposure and outcomes. Being observational in nature, cohort studies are, however, subject to confounding, and other factors that are linked with exposure of interest can account for some or all of the associations that are observed. (Kestenbaum 2009).

In Studies II and III, the study population comprised those 4,999 war veterans who participated in both the Veteran Project 1992 and 2004 surveys, veterans in these studies representing a selected group who survived to older ages. Study III was a so-called nested-case control study, where the ability of veterans' mental and physical conditions and the worsening of these conditions to predict veterans' functional impairment 12 years in advance were examined.

In Studies I–III, logistic regression models were used and ORs with 95% CIs were calculated to control the confounding variables. The advantages of regression models are that they can account for multiple confounders simultaneously and deal with both continuous and dichotomous confounding variables (Kestenbaum 2009).

Study IV was a prospective follow-up study based on the study population of the Veteran Project 1992 survey population with an average follow-up time of 9.9 years utilizing the national Causes of Death Register. In Study IV, the Cox proportion hazards model was used and HRs with 95% CIs were calculated. The benefit of the Cox proportion hazards model is that the model allows for simultaneous adjustment of multiple confounding factors and handles differences in follow-up time and censoring between groups (Kestenbaum 2009).

6.8 Strengths and limitations

6.8.1 Strengths of the study

The strength of this study is the unique study population, because almost every man capable of activities on the frontline served in the Finnish Defense Forces between 1939 and 1944. Thereby, the results concern practically the general entire Finnish male population of the same age. The long follow-up enabled the examination of longitudinal aging effects among veterans. The response rate was high in both surveys (93% in 1992 and 87% in 2004), which indicates high external validity of the findings. The present thesis also contains a wide range of variables in a combination that only a few other studies have had access to. Mortality data from the Finnish national Causes of Death Register administered by Statistics Finland were linked to the survey using the personal identification numbers assigned to every resident of Finland. Thus, the mortality follow-up and ascertainment of living status were complete.

6.8.2 Limitations of the study

The limitation of this thesis is the lack of a non-veteran control group of the same age. The National Institute for Health and Welfare has conducted a biennial postal survey among 65–84-year-old Finnish citizens since 1985 (Helldán & Helakorpi 2014), but it shares the same population as our study. Therefore, it is not possible to assess whether the changes in veterans' health and functional capacity were the consequence of aging but also of intervention for veterans or other simultaneous changes in elderly care.

Unfortunately, activities of daily living were not determined in 1992. Thus, assessing the change in the functional status during the follow-up is not possible. Worsening symptoms or the onset of new diseases during the follow-up may be the reason for the functional decline, but functional status impairment may also give rise to certain diseases, such as depression. When asked to rate their health, some people think about specific health problems, whereas others think of either general physical functioning or health behaviors (Molarius & Janson 2002). Self-reported measures may also give a more optimistic view of physical abilities than performance-based measures (Sinoff & Ore 1997), and self-reported chronic conditions may introduce a source of error. A considerable proportion of respondents in the study reported impaired memory, which may have influenced the answers. The questionnaires may have been filled in by personal assistants, which may have influenced the results. Confounding variables such as smoking, cholesterol, and weight were not recorded, which is also a lack in the present study. Finally, it must be noticed that the veterans in this study represent a selected group who have survived to older ages.

6.9 Perspectives for the future

This thesis provides a comprehensive picture of factors associated with changes in SRH, functional capacity and mortality among Finnish war veterans. Although the number of Finnish Second War veterans is rapidly decreasing, the proportion of people aged 65 years and over will increase during the next decades, and results of our thesis can be used to identify vulnerable older adults at high risk for future disability. Mobility disability as a marker of frailty indicates the lower resources of elderly people and can be easily assessed in any clinical setting. By maintaining the mobility of older adults with necessary technical aids, well-timed rehabilitation and an appropriate environment, and by preventing chronic disease

and treating acute conditions effectively, it is possible to improve older adults' functional capacity and to enable their independent living in the community. Further work is still needed to find out what kind of health and rehabilitation services would be the most effective for doing this.

7 Conclusions

1. Self-rated health and functional capacity was better among 80–84-year-old Finnish war veterans in 2004 compared with 1992, although the prevalence of many diseases increased during the follow-up.
2. Participation in rehabilitation programs was not associated with the ability to walk 500 m without difficulties.
3. The majority of the 4,999 war veterans who participated in both Veteran Project surveys rated their health as improved or unchanged during the follow-up.
4. Mobility impairments and cardiovascular, musculoskeletal and neurological diseases were found to be predictors of declined SRH among the 4,999 veterans who participated in both Veteran Projects.
5. Neurological and musculoskeletal diseases, but especially walking difficulties, may predict veterans' future functional impairment as many as 12 years in advance, and worsening of these conditions is associated with impaired ADL.
6. During an average 9.9-year follow-up, walking difficulties alone or together with multimorbidity and/or with a third risk factor was the most important risk factor for total and for CVD mortality among all veteran groups.

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- I Leskinen MR, Laatikainen TK, Tuomilehto JO, Nissinen MA, Peltonen M, Koistinen PO, Antikainen RL (2010) Trends in health status and the use of services among the 80–84-year-old Finnish war veterans during 1992 and 2004. *Scand J Public Health* 38(4): 434–441.
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