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# Suicide, violent crime, divorce and mortality in deployed military veterans

Carl-Martin Pethrus



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Suicide, violent crime, divorce and mortality in deployed military veterans  
THESIS FOR DOCTORAL DEGREE (Ph.D.)

By

**Carl-Martin Pethrus**

*Thesis Defense*

Haga Forum, Hörsal Ett, Annerovägen 4, Solna  
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*Principal Supervisor*

Professor Martin Neovius  
Karolinska Institutet  
Department of Medicine (Solna)  
Division of Clinical Epidemiology

*Co-Supervisors*

Assistant Professor Gustaf Bruze  
Karolinska Institutet  
Department of Medicine (Solna)  
Division of Clinical Epidemiology

Assistant Professor Kari Johansson  
Karolinska Institutet  
Department of Medicine (Solna)  
Division of Clinical Epidemiology

Associate Professor Johan Reutfors  
Karolinska Institutet  
Department of Medicine (Solna)  
Division of Clinical Epidemiology  
Centre for Pharmacoepidemiology

*Opponent*

Associate Professor Per-Olof Michel  
Uppsala University  
Chief Military Psychiatrist (1993-2006), Swedish  
Armed Forces

*Examination Board*

Professor Yvonne Forsell  
Karolinska Institutet  
Department of Public Health Sciences

Professor Paul Dickman  
Karolinska Institutet  
Department of Medical Epidemiology and  
Biostatistics

Associate Professor Filip Arnberg  
Uppsala University  
Department of Neuroscience



## ABSTRACT

It has long been known that individuals deployed to war and conflict zones might suffer from mental health problems after returning home. This thesis investigated suicide, violent crime, divorce and marriage in deployed Swedish military veterans (study I-III), as well as all-cause and cause-specific mortality in Nordic military veterans (study IV), deployed between 1990 and 2013.

The analyses were based on a linkage of the Swedish Armed Forces' register of deployed veterans and nationwide registers. To limit the impact of "the healthy soldier effect", that is the tendency of veterans to be healthier than the general population due to military selection criteria, a tightly matched comparison group was created using individual level information on mental and physical health in addition to age- and sex-matched comparators. In Study IV, Danish, Finnish and Norwegian deployed veterans were also analysed.

In **Study I**, we found that the risk of death by suicide after return from deployment in more than 20,000 Swedish military veterans who had been deployed between 1990 and 2013 was similar to the tightly matched non-deployed comparators (1.5 versus 1.6 per 10,000 person-years; hazard ratio [HR] 1.07; 95%CI 0.75-1.52).

In **Study II**, we found that Swedish military veterans who had deployed to Afghanistan sometime between 2002 and 2013 were more likely to divorce (277 versus 178 per 10,000 person-years; HR 1.56, 95%CI 1.27-1.91) and less likely to marry (399 versus 444 per 10,000 person-years; HR 0.89, 95%CI 0.83-0.96) after return from deployment compared with the tightly matched non-deployed comparators.

In **Study III**, we found that Swedish military veterans who had deployed to Afghanistan had a similar violent crime conviction rate after return from deployment as the tightly matched comparators (12 versus 9 per 10,000 person-years; HR 1.36, 95%CI 0.88-2.10).

In **Study IV**, we found lower all-cause mortality in military veterans from Sweden, Denmark, Finland and Norway deployed between 1990 and 2010 compared with the general population. Lower risk was also observed for death from external causes, suicide, cardiovascular disease and neoplasms. There was, however, no difference in risk of fatal traffic/transport accidents between deployed military veterans and the general population.

In summary, this thesis found no association between military deployment and death by suicide or violent crime conviction in Swedish veterans versus non-deployed comparators who were similar with respect to several factors. However, higher probability of divorce and lower probability of marriage after return from deployment were observed among the veterans. In terms of mortality outcomes, Nordic military veterans were similar and had consistently lower, or similar, risk of death after return from deployment compared with the general population.

## SAMMANFATTNING (SUMMARY IN SWEDISH)

Det har länge varit känt att individer som deltar i krig eller tjänstgör i konfliktområden kan lida av psykisk ohälsa efter hemkomst. Denna avhandling undersökte självmord, våldsbrott, skilsmässa och giftermål bland svenska militära utlandsveteraner (studie I-III), samt allmän och orsaksspecifik dödlighet bland nordiska militära utlandsveteraner (studie IV), som tjänstgjort vid en internationell insats någon gång mellan 1990 och 2013.

Analyserna baserades på länkning av Försvarsmaktens register över militära utlandsveteraner och rikstäckande administrativa register. För att begränsa inverkan av "the healthy soldier effect", det vill säga effekten av veteranernas tendens att vara friskare än allmänbefolkningen på grund av de militära urvalskriterierna, skapades en noggrant matchad jämförelsegrupp genom att använda data på individnivå över psykisk och fysisk hälsa utöver en ålders- och könsmatchad jämförelsegrupp. I studie IV analyserades också danska, finska och norska militära utlandsveteraner.

I **studie I** fann vi att risken för självmord efter hemkomst bland mer än 20 000 svenska militära utlandsveteraner som varit på internationell insats mellan 1990 och 2013 var lik risken hos de noggrant matchade jämförelseindividerna (1.5 jämfört med 1.6 per 10 000 personår; hasardkvot [HR] 1.07; 95%CI 0.75-1.52).

I **studie II** fann vi att svenska militära utlandsveteraner som tjänstgjort i Afghanistan någon gång mellan 2002 och 2013 genomgick skilsmässa i större utsträckning (277 jämfört med 178 per 10 000 personår; HR 1.56, 95%CI 1.27-1.91) och ingick äktenskap i mindre utsträckning (399 jämfört med 444 per 10 000 personår; HR 0.89, 95%CI 0.83-0.96) efter hemkomst jämfört med de noggrant matchade jämförelseindividerna.

I **studie III** fann vi att svenska militära utlandsveteraner som tjänstgjort i Afghanistan hade en liknande risk att dömas för våldsbrott efter hemkomst jämfört med de noggrant matchade jämförelseindividerna (12 jämfört med 9 fall per 10 000 person-år; HR 1.36, 95%CI 0.88-2.10).

I **studie IV** fann vi en lägre allmän och orsaksspecifik dödlighet bland militära utlandsveteraner från Danmark, Finland, Norge och Sverige som tjänstgjort vid en internationell insats mellan 1990 och 2010 jämfört med allmänbefolkningen. Däremot kunde ingen skillnad i risk för dödliga trafik-/transportolyckor mellan militära utlandsveteraner och allmänbefolkningen.

Sammanfattningsvis fann denna avhandling ingen koppling mellan militär utlandstjänstgöring och självmord eller våldsbrottsdom bland svenska veteraner som tjänstgjort mellan 1990 och 2013 jämfört med jämförelseindivider från allmänbefolkningen med liknande psykiska och fysiska karakteristika. Däremot observerades en högre sannolikhet för skilsmässa och en lägre sannolikhet för giftermål efter hemkomst bland de militära utlandsveteranerna. Vad gällde dödlighet uppvisade de nordiska militära utlandsveteranerna en konsekvent lägre, eller liknande, dödsrisk efter hemkomst jämfört med allmänbefolkningen.

## LIST OF SCIENTIFIC PAPERS

- I. **Pethrus CM**, Johansson K, Neovius K, Reutfors J, Sundstrom J, Neovius M  
Suicide and all-cause mortality in Swedish deployed military veterans:  
a population-based matched cohort study  
*BMJ Open. 2017;7(9):e014034.*
- II. **Pethrus CM**, Reutfors J, Johansson K, Neovius K, Söderling J, Neovius M, Bruze G  
Marriage and divorce after military deployment to Afghanistan:  
a matched cohort study from Sweden  
*PLoS One. 2019;14(2):e0207981.*
- III. **Pethrus CM**, Frisell T, Reutfors J, Johansson K, Neovius K, Söderling J, Bruze G, Neovius M  
Violent crime among Swedish military veterans after deployment to  
Afghanistan: a population-based matched cohort study  
*International Journal of Epidemiology In Press*
- IV. **Pethrus CM**, Vedtofte MS, Neovius K, Borud EK, Neovius M  
All-cause and cause-specific mortality among Nordic military veterans  
following international deployment: a meta-analysis  
*Manuscript*

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## LIST OF ABBREVIATIONS

aHR	Adjusted hazard ratio
BMI	Body mass index (kg/m <sup>2</sup> )
CI	Confidence interval
HR	Hazard ratio
ISAF	International Security Assistance Force
NGO	Non-governmental organisation
PRIO	PRIO is the name of a personnel register at the Armed Forces. It is not an acronym and does not carry a specific meaning.
PTSD	Post-traumatic stress disorder
SMR	Standardised mortality ratio
SWIP	Swedish Military Information Personnel Register
UK	United Kingdom
UN	United Nations
US	United States



# 1 OBJECTIVES & RATIONALE

The overall objective of this thesis was to perform a large-scale investigation of health and social outcomes of Swedish veterans after international military missions and matched comparators not deployed abroad. The study-specific objectives and rationales were:

## **Study I Suicide & all-cause mortality**

To investigate suicide and mortality risk in deployed military veterans versus non-deployed comparators who had gone through military conscription testing.

### **Brief rationale**

Study I is an update of the only published register-based study on suicide among Swedish military veterans,<sup>1</sup> but includes also the outcomes all-cause mortality and non-fatal self-harm. Study I also investigates the “healthy soldier effect” which was not done in the previous Swedish publication.

## **Study II Marriage & divorce**

To investigate the probability of marriage and divorce after return from deployment to Afghanistan among Swedish military veterans versus non-deployed comparators.

### **Brief rationale**

*Divorce:* Several US studies have investigated the association between military deployment and divorce, but these data may not be generalizable to the European setting.

*Marriage:* The association between deployment and new marriages has received little attention.

## **Study III Violent crime**

To investigate violent crime after return from deployment to Afghanistan in Swedish military veterans versus non-deployed comparators.

### **Brief rationale**

The use of violence may be more common in military personnel than the general population.

International studies have found that combat and traumatic experiences during deployment are associated with an increased risk of violent crime among veterans.

The media has reported about violent acts committed by Swedish veterans deployed to Afghanistan, but no large-scale investigations have been conducted.

## **Study IV All-cause & cause-specific mortality in Nordic military veterans**

To estimate all-cause and cause-specific mortality for Nordic military veterans versus the general population using data from Denmark, Finland, Norway and Sweden.

### **Brief rationale**

Certain specific causes of death, such as fatal traffic accidents and cancer, are rare. Using data from a single Nordic country may therefore result in low statistical power to detect true effects. By pooling data from the Nordic countries, greater statistical power can be achieved.

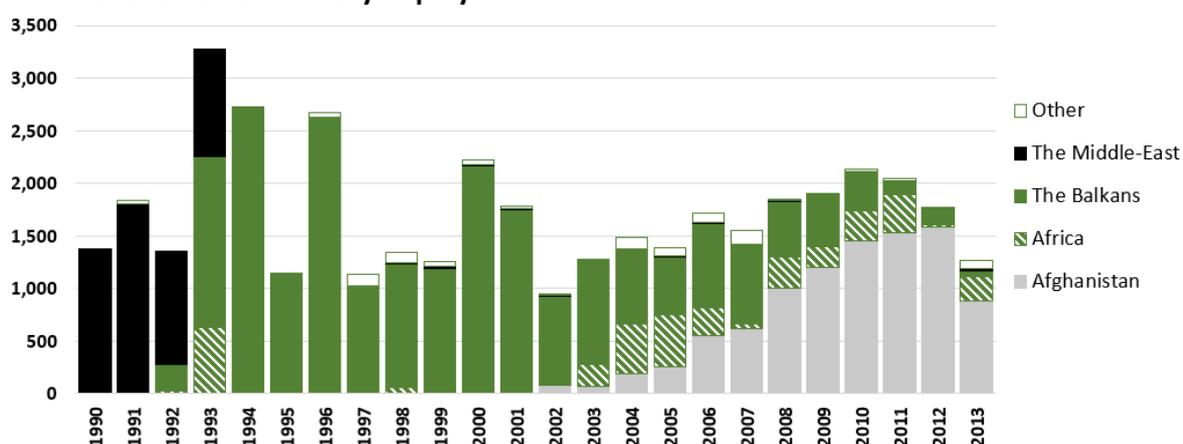
## 2 INTRODUCTION

### 2.1 INTERNATIONAL MILITARY DEPLOYMENT

Since 1965, Sweden has contributed with military troops to conflicts sanctioned by the United Nations (UN). This thesis focuses on Swedish military veterans deployed to such operations between 1990 and 2013 shown in **Figure 1**.

In the early 1990s, the Middle-East (primarily Lebanon) was the main deployment area for Swedish military troops sent abroad. Thereafter, operations in the Balkans dominated for the rest of the 1990s and in the beginning of the 2000s. Starting in 2002, the Swedish contribution with military troops to the International Security Assistance Force (ISAF) in Afghanistan increased for a number of years, reaching about 90% of all Swedish deployments in 2012. In subsequent years, the number of Swedish military deployments to Afghanistan decreased, and in 2014 the ISAF operation was formally terminated. During the period 1990 to 2013, between 900 and over 3000 Swedish military servicemen and women were deployed annually.

**Number of Swedish military deployments**



**Figure 1** Swedish military deployments between 1990 and 2013 by region or country

### 2.2 MILITARY DEPLOYMENT & MENTAL HEALTH

At least since nightmares in combat veterans from the Trojan War were described by Homer in the Iliad,<sup>2</sup> it has been known that combat survivors might suffer from mental health problems after returning home. These problems have often appeared with diffuse symptoms and are difficult to diagnose. Over time they have been assigned various labels, for example “shell shock” or “trench neurosis” during World War I<sup>3,4</sup> and “battle fatigue” during World War II.<sup>3</sup>

The suffering in veteran populations in the wake of the recent wars in Afghanistan and Iraq is usually described as post-traumatic stress disorder (PTSD), including a variety of symptoms such as nightmares and angry outbursts after having experienced a traumatic event. These symptoms are associated with several negative consequences for the individual. Apart from the direct suffering, some of these negative effects include intimate relationship problems, violence and criminality.<sup>5,6</sup>

The prevalence of PTSD has been reported to be about 10% in US veterans from Operation Enduring Freedom in Afghanistan and up to 20% in US veterans from Operation Iraqi Freedom.<sup>7-9</sup> The prevalence of PTSD in US veteran populations from these military operations thus seems to be in the same range as that for Vietnam war veterans, where the PTSD

prevalence has been estimated to 15-17%.<sup>10,11</sup> In European veteran populations from the recent wars in Afghanistan and Iraq the reported PTSD prevalence is consistently lower, ranging from 1-10%.<sup>12-16</sup>

Suicide, also associated with PTSD, has been reported to have increased in frequency in US veterans from the recent wars in Iraq and Afghanistan. US veterans now show a suicide frequency similar to that of the general population, while their rate used to be substantially lower.<sup>17</sup>

Whether a similar increase in suicide rate has occurred in veteran populations from other countries has not been reported in the scientific literature. For Swedish military veterans, an almost 50% lower suicide rate in veterans deployed between 1960 and 1999 has been reported compared with the general population of the same age and sex.<sup>1</sup> Before the start of this thesis no study on suicide in Swedish military veterans deployed after 1999 had been published.

### **2.3 POTENTIAL MECHANISMS UNDERLYING ADVERSE EFFECTS OF MILITARY DEPLOYMENT**

There are several potential mechanisms by which military deployment may influence mental health problems, violent crime and marital problems, as well as all-cause and cause-specific mortality.

#### **2.3.1 Mental health & suicide**

PTSD is a diagnosis characterised by a host of symptoms, including lack of concentration, nightmares, flashbacks, avoidance and negative beliefs about oneself and others that persist after having experienced or witnessed a traumatic, violent or threatening event.<sup>18</sup> The possibility of such events to occur during military deployments is evident. PTSD is associated with a variety of negative consequences, for example suicidal ideation and death by suicide.<sup>6</sup>

It is also possible that several deployment-related factors, such as high levels of stress and tension over an extended period and re-adjustment difficulties after returning home, could have a negative impact on the mental health of veterans in the absence of specific traumatic events.

#### **2.3.2 Marriage & divorce**

There are several potential mechanisms associated with military deployment that affect marriage and divorce. The most obvious mechanisms are the extended physical separation from the partner and family and the adverse effects of trauma during deployment.<sup>19</sup> The family left at home could realise that they do well without the deployed family member, and therefore have little patience with the veteran's subsequent re-adjustment problems. The physical separation could also have a cooling effect on the relationship, although the opposite is also possible.<sup>20</sup> When investigating the consequences of trauma, several studies of military veterans have reported a negative effect on close relationships from mental illnesses, including PTSD, which consists of such symptoms as feelings of detachment and estrangement from others.<sup>21-23</sup>

Furthermore, individuals who volunteer to serve in war zones could have an adventurous personality poorly suited for long-term relationships and the mundane family lifestyle. Reverse causality is also possible regarding marital problems, since it could be the case that individuals choose to enroll for military deployment to escape a non-functioning relationship.

Finally, divorce does not need to represent a negative outcome. It is possible that new friends, new experiences and new perspectives from international military deployment could generate the mental energy needed to break-up from a toxic or non-functioning relationship.

### **2.3.3 Violent crime**

Mental health problems (primarily PTSD) after military deployment have been reported to be associated with anger and aggressive behaviour, which can be expressed as destruction of property and violence against individuals, not seldom the intimate partner.<sup>24-28</sup> Among the different PTSD symptoms, studies suggest that hyperarousal in particular can be linked to aggressive behaviour.<sup>22,29-34</sup> Psychological theories predict that arousal intensifies the experience of anger and is associated with aggressive reactions.<sup>35,36</sup>

Alcohol misuse, sometimes described as “self-medication” in veteran populations, is often associated with mental health problems from combat exposure or other traumatic experiences.<sup>32</sup> Some studies have also reported alcohol consumption to be a common link between PTSD and aggression,<sup>37,38</sup> and that alcohol consumption possibly interacts with PTSD, creating a particularly explosive cocktail for violent behaviour.<sup>24</sup>

Violent behaviour among military veterans could also be a result of the military profession itself. Violence is typically not socially accepted, but within the military it is a central means to achieve defined objectives, and specific training in use of violence is provided. It has been suggested that individuals who have adapted to and accepted the values regarding military-related violence might extend this view to other areas in life, where violence is not tolerated or appropriate.<sup>39-41</sup>

Another possible explanation of violent behaviour among military veterans can be that the armed forces in some countries recruit primarily from groups with low socio-economic status, a factor linked to criminal convictions.<sup>40,42</sup>

### **2.3.4 Mortality**

There are several possible pathways between foreign military deployment and mortality after returning home from deployment.

Foreign military deployment could for instance be associated with hazardous exposure to chemicals and radiation, which could cause negative health effects, there among cancer, in the veterans. Agent Orange, a chemical used to defoliate trees during the Vietnam War, and depleted uranium, used in warheads, have been given special attention in this regard, but so far studies have failed to establish a clear link between exposure and most subsequent negative health effects.<sup>43-45</sup>

Associations between PTSD and increased blood pressure and heart rate have also been reported,<sup>46,47</sup> possibly through the mechanism of high stress levels. This increased blood pressure could be a burden for the heart and blood vessels, eventually leading to cardiovascular events (for example myocardial infarction or stroke).

Furthermore, it has been proposed that veterans might have increased risk-taking behaviour after repatriation as a consequence of foreign military deployment.<sup>48</sup> Such risk-taking behaviour could possibly lead to an increased risk of death from external causes in veterans (for example injuries and traffic accidents).

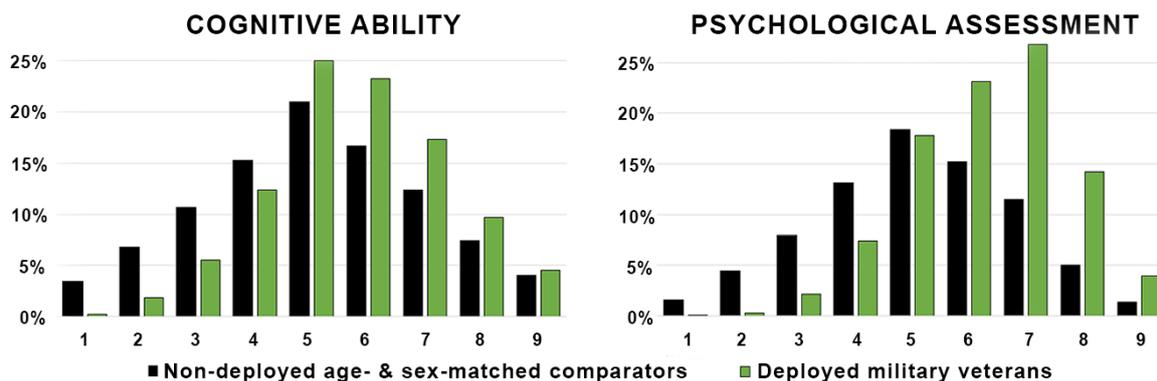
Finally, all-cause mortality can serve as an indicator of illnesses of any kind, with known or unknown causes, as well as conceal misclassification in register studies.

## 2.4 THE HEALTHY SOLDIER EFFECT

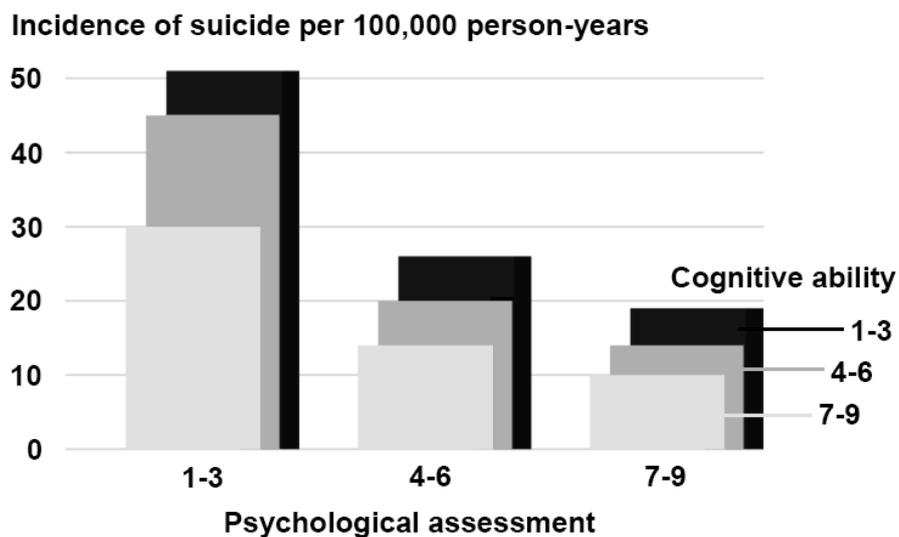
Individuals recruited to serve in international military operations are selected based on their mental and physical ability. Therefore, veteran populations are likely to be healthier than the general population. This systematic bias in studies comparing veterans to the general population is referred to as "the healthy soldier effect" in the scientific literature, and is analogous to the healthy worker effect phenomenon.<sup>49,50</sup>

Because of the healthy soldier effect, mortality has been estimated to be 10-25% lower in veteran populations compared with the general population.<sup>49</sup> The effect is expected to be most pronounced in the initial years after enlistment, as frail individuals in the general population who are unfit for deployment and more likely to die prematurely are either not applying or not qualifying. However, the healthy soldier effect appears to linger long after deployment. American World War II veterans, for example, have been reported to have lower mortality than the general population still 23 years after the war.<sup>50</sup>

In **Figure 2**, the test scores from military conscription testing of cognitive ability and psychological assessment are shown for deployed Swedish military veterans and non-deployed comparators matched for age, sex and conscription year. The higher results in veterans for both these variables are a representation of the healthy soldier effect. **Figure 3** shows how cognitive ability and psychological assessment test scores are associated with incidence of suicide in individuals who performed military conscription tests.



**Figure 2** Intelligence score and psychological assessment score, deployed military veterans versus non-deployed age- & sex-matched comparators



**Figure 3** Association between cognitive ability, psychological assessment score, and death by suicide in individuals who performed military conscription tests

## **2.5 BACKGROUND TO STUDY I-IV**

### **2.5.1 Suicide in deployed military veterans (Study I & Study IV)**

Suicide can be viewed as the ultimate manifestation of mental health problems. Although deployed military personnel are exposed to potentially traumatic events with possible long-term adverse mental health consequences after deployment, suicide rates after deployment among veterans are typically well below those in the general population.<sup>1,51,52</sup> These findings are most probably due to the healthy soldier effect (the veterans constitute a carefully selected population).<sup>49</sup>

However, recent data suggest that this pattern might have changed in the US. A large study of American veterans from the recent wars in Iraq and Afghanistan found that the suicide rate in this population was at the same level as in the general population.<sup>17</sup> This apparent relative increase in the suicide rate among American veterans could have several explanations. For instance, it is possible that the pressing need for personnel during these wars has forced a relaxation of the recruitment criteria, which may have attenuated the healthy soldier effect. This hypothesis is supported by a large cohort study of all US service members between 2001 and 2007 (deployed as well as non-deployed), including all 3.9 million military personnel deployed to Iraq, where no association between deployment and suicide could be detected,<sup>53</sup> despite the fact the suicide rate had increased in this population.<sup>54</sup>

Little is known about whether a similar increase in the suicide rate has occurred in European veteran populations from the recent wars in Iraq and Afghanistan.

### **2.5.2 Marriage & divorce in deployed military veterans (Study II)**

There is a general belief that military veterans struggle with intimate relationships and re-adjustment to family life after deployment.<sup>55</sup> However, there is no clear empirical support for this contention. Moreover, there is little scientific evidence regarding the extent to which veterans get married after deployment, and published data on divorce after deployment are contradictory and inconclusive.

The divorce rate in society as a whole was doubled in the US during World War II,<sup>56</sup> which could at least partly be explained by “hasty marriages”, that is soldiers marry in haste because of the upcoming deployment to war zones.<sup>55</sup> Later studies did not find an increased divorce rate in American Vietnam veterans,<sup>56-58</sup> and studies of American veterans deployed during the 1990s to peace-keeping missions and to the Gulf War have not reported decreased marital quality after deployment.<sup>20,59,60</sup>

Concerning the recent large military engagements in Iraq and Afghanistan, studies of divorce among veterans show contradictory results. In a sample of American veterans (n=5928) deployed to these war zones in 2003-2009, a decrease in marital quality and an increase in divorce intent have been reported.<sup>61</sup> However, no change in divorce rate was observed during the same period in a larger sample (n=1,895,571).<sup>61</sup>

An unchanged divorce rate from the recent wars in Iraq and Afghanistan has been observed also in other studies. Based on a register with more than 6 million American soldiers employed during 1996 and 2005, Karney et al were unable to detect any increase in divorce rate associated with the wars in Iraq and Afghanistan.<sup>62</sup> In addition, in an analysis of the association of deployment duration and divorce, the authors found no association or, depending on type of

deployment, even a negative association (that is the longer the deployment, the lower the probability of divorce).

This surprising finding, however, is contradicted by the results of two other register studies in the field. Negrusa et al found that both longer deployments and PTSD were independently associated with increased probability of divorce based on a register of more than 70,000 American veterans deployed to primarily Iraq and Afghanistan.<sup>63</sup> The positive association between deployment duration and probability of divorce was confirmed in another study by Negrusa et al based on a register of 400,000 American soldiers who started military duty and married between 1999 and 2008, the period of the wars in Iraq and Afghanistan.<sup>63</sup> The authors propose that the lack of association between deployment and divorce can be explained by the short follow-up in the study by Karney et al, arguing that divorce is an outcome that does not occur directly after return from deployment.

Studies of European veterans from the wars in Iraq and Afghanistan have consistently reported lower levels of PTSD in these populations compared with the corresponding American veteran populations.<sup>64,65</sup> One could therefore hypothesise that the marriage and divorce rates among European veterans from these war zones may be less affected by deployment than among American veterans. However, no such investigation among European veterans has been conducted and published in the scientific literature.

### **2.5.3 Violent crime in deployed military veterans (Study III)**

In the military, recruits are trained to use different forms of violence. It has been hypothesised that veterans may therefore use violence outside of military settings, where it is inappropriate and illegal.<sup>12,40,66</sup> Dramatic violence was also one of the criteria of the malignant post-Vietnam syndrome, a precursor of PTSD.<sup>67</sup> Military veterans have also been reported to be the largest group by profession in British prisons,<sup>42</sup> and it has been estimated that 1 in 5 of American Gulf War veterans has been imprisoned after deployment.<sup>68</sup> A meta-analysis of aggressive and violent behaviour among American and British veterans from the recent wars in Iraq and Afghanistan estimated that 1 in 10 of the veterans engaged in physical assault during the past month and 1 in 3 engaged in some type of physical aggression.<sup>69</sup>

There are also numerous case reports in the media of extremely violent behaviour among soldiers who have returned from the recent wars in Iraq and Afghanistan, adding to the myth of military veterans as "wacko-vets".<sup>70</sup> However, such case reports may not be representative of the veteran population as a whole, and violent crimes committed by veterans may not be causally related to deployment. For example, the armed forces in some countries actively recruit in areas characterised by social misery and high criminality.<sup>40,42</sup>

Larger-scale studies from the US and UK have investigated the association between military deployment and violent crime. A study using American data from the Health Care for Reentry Veterans program (an outreach programme within the Veterans Health Administration) examining the risk of incarceration after deployment to Afghanistan or Iraq found that deployed veterans were less likely to be incarcerated than veterans from other war zones.<sup>71</sup> A register study of British veterans deployed to Iraq or Afghanistan found that combat and traumatic experiences, as well as PTSD and alcohol abuse after deployment, were associated with an increased risk of violent crime.<sup>30</sup> The study could not detect a specific association between deployment per se and violent crime, however.<sup>30</sup>

Sweden deployed military personnel to Afghanistan within ISAF between 2002 and 2014. There have been reports of violent behaviour among these veterans: for instance, the Swedish daily press reported on the brutal “Dalby murder” in which a Swedish military veteran, allegedly suffering from traumatic experiences from his deployment to Afghanistan, killed his wife and child.<sup>72</sup> No study has investigated the incidence of violent crime among the complete cohort of Swedish veterans deployed to Afghanistan.

#### **2.5.4 Mortality in deployed Nordic military veterans (Study IV)**

The Nordic countries have all contributed with military personnel to conflict areas in modern time. In the 1990s, for example, a large number of soldiers and officers from Denmark, Finland, Norway and Sweden were deployed to the Balkans and in the 2000s, all four Nordic countries deployed soldiers to Afghanistan.<sup>73-77</sup>

Studies suggest that veterans from these countries in general cope well with the exposures associated with military deployment. Although individual cases of the negative consequences of severe physical and psychological trauma during deployment exist, post-deployment physical or mental health problems do not seem to be a major issue on a population level among Nordic veterans. On the contrary, register studies of all-cause or cause-specific mortality, primarily suicide, have typically found a lower risk among Nordic veterans than in the general population in each country,<sup>73-75,77</sup> most likely due to the healthy soldier effect.

Because of the relatively small veteran populations in each Nordic country, some important health outcomes related to military deployment are difficult to study. One such outcome is cancer and cancer deaths, which may be causally related to deployment by way of exposure to chemicals or biological agents during deployment. For these outcomes, the number of cases in each country may be too small to generate a meaningful statistical analysis. Another such outcome is fatal traffic accidents, which in the case of register studies could contain also misclassified suicides.

The similarities between the Nordic countries in terms of population, military engagements and universal health care systems, as well as the use of nationwide registers, offer a unique opportunity to synthesise data from the different countries to improve the statistical power for analyses of rare post-deployment outcomes. However, no such meta-analyses have been conducted.

### 3 MATERIALS & METHODS

Study I-III in this thesis included only Swedish data and were designed as matched cohort studies; the fourth study was a meta-analysis pooling cohort study estimates from Denmark, Finland, Norway and Sweden.

#### 3.1 DATA SOURCES

Data from the following registers were used in this thesis:

*The Military Service Conscription Register:* Sweden had mandatory military service until 2010. This meant that all men were subjected to conscription tests (from 1990, the possibility for women to volunteer was introduced). The military conscription was enforced by law and only individuals with severe handicaps or chronic diseases along with non-Swedish citizens were exempted.<sup>78</sup> Conscription normally took place during the individual's last year in high school. Until 2006, the number of men performing conscription tests was about 40,000-60,000 annually, but from 2007 this number started to decrease drastically.<sup>79</sup> The mandatory military service was deferred 2010 but was reintroduced in 2018 and is now mandatory also for women.<sup>80</sup>

The results from the conscription tests have been stored in the Military Service Conscription Register. Apart from measured physical variables (such as height, weight and blood pressure), this register includes data on several other variables of interest for research, for example cognitive ability, psychological assessment and self-reported mental health.

*The Swedish Military Information Personnel (SWIP) and PRIO Registers:* Since 1965, data on Swedish citizens who have been deployed by the military, except individuals serving in the Special Forces and classified personnel, have been stored in the SWIP register, which is maintained by the Armed Forces. In 2012, the SWIP register was merged with and replaced by the PRIO register (PRIO is not an acronym and does not carry a specific meaning). The register contains information about, for example, country of deployment, date of deployment and return, sex, age, military rank, and regiment.

*The Total Population Register:* The purpose of this register, maintained by Statistics Sweden since 1968, is primarily to produce statistics on the size of the Swedish population. It also contains information about dates of emigration, immigration, marriage and divorce.<sup>81</sup>

*The National Patient Register:* This register was started in 1964 and attained nationwide coverage for inpatient care in 1987.<sup>82</sup> In 2001, hospital-based outpatient care was added. Among other data, the register contains date of visit, date of discharge (for inpatient care), main diagnoses, secondary diagnoses and surgery codes.

*The Prescribed Drug Register:* In July 2005, Sweden launched a nationwide prescribed drug register with the purpose to increase patient safety and to gain better understanding of the side effects of prescription drugs.<sup>83</sup> The register contains all filled prescriptions in Sweden.

*The Register of Criminal Convictions:* Initiated in 1973 and maintained by The Swedish National Council for Crime Prevention (Swedish: Brottsförebyggande rådet, Brå), this register includes information on convictions retrieved from all lower courts in Sweden. With close to complete coverage, the data include such information as date, criminal offence and sentence.

## 3.2 STUDY I-III

### 3.2.1 Study population

Swedish deployed military veterans were identified through the SWIP and PRIO databases. Study I comprised all identified veterans with an international military deployment between 1990-01-01 and 2013-12-31; study II and III only included veterans who had been deployed to Afghanistan between 2002-01-01 and 2013-12-31.

From the Military Service Conscription Register two comparator groups were selected that included individuals who performed conscription tests but who had not been deployed by the military. For each comparator group, five comparators were matched to each veteran.

The first comparator group served as a general population benchmark and matching factors were only age, sex and conscription year (“age- and sex-matched comparators”). The second comparator group was more meticulously matched to the deployed veterans to eliminate or at least significantly reduce the healthy soldier effect (“tightly matched comparators”; **Table 1**).

**Table 1** Matching variables in Study I, II and III for tightly matched non-deployed comparator group

Study	Veterans	Matching factors
I	All deployments irrespective of region, 1990-2013	Age, sex, conscription year, calendar year of deployment Cognitive ability, psychological assessment, self-reported mental health, BMI
II	Deployments to Afghanistan, 2002-2013	Age, sex, conscription year, calendar year of deployment Marital status, history of divorce Cognitive ability, psychological assessment, self-reported mental health, BMI, Pre-deployment history of violent crime convictions, self-harm, and one or more prescription fillings of antidepressants or anxiolytics
III		Age, sex, conscription year, calendar year of deployment Cognitive ability, psychological assessment, self-reported mental health, BMI, Pre-deployment history of self-harm, and one or more prescription fillings of antidepressants or anxiolytics <i>Exclusion: Individuals with a pre-deployment history of violent crime conviction</i>

### 3.2.2 Follow-up & outcomes

Start of follow-up was the day of return to Sweden after deployment for each deployed military veteran (their non-deployed matched comparators were given the same date as the index date). Deployed military veterans and their comparators were thereafter followed until the event of interest, emigration, death or last date of register-based follow-up, whichever occurred first. The veteran populations, follow-up, outcome and outcome register sources are outlined in **Table 2**.

**Table 2** Veteran populations, follow-up, outcomes and outcome sources in Study I-III

Study	Veterans	End of Follow-up	Outcomes	Outcome sources
I	All veterans 1990-2013	2013-12-31	Suicide, suicide attempts/self-harm, all-cause mortality	Causes of Death Register National Patient Register
II	Afghanistan	2014-12-31	Marriage & divorce	Total Population Register
III	2002-2013	2013-12-31	Violent crime	Criminal Conviction Register

### **3.3 STUDY IV**

Study IV is a meta-analysis based on register data for military veterans and outcomes from Denmark, Finland, Norway and Sweden. The cohorts were created and outcome data collected by linking nationwide registers through the unique personal identity number assigned to each resident in the respective countries.

#### **3.3.1 Study population**

Individuals from Denmark, Finland, Norway and Sweden who had served on any international military deployment between 1992-01-01 (1990-01-01 for Finland) and 2010-12-31 were identified from the Armed Forces registers of international deployments in each country. All details for Finnish military veterans were retrieved from a published paper.<sup>73</sup>

The veterans were compared to the general population in each country by the use of the standardised mortality ratio (SMR) using population mortality data by age, sex and time period.

#### **3.3.2 Follow-up & outcomes**

The veterans were followed regarding death from any cause, external causes (including suicide and traffic/transport accidents studied separately), cardiovascular causes, suicide, traffic/transport accidents, and from neoplasms.

Veterans were followed until death, emigration, or last date of register-based follow-up (2016-12-31 for Denmark, Norway and Sweden; 2013-12-31 for Finland), whichever occurred first. The dates and causes of death for the veterans were retrieved from each country's national government agency managing the Causes of Death Register.

## 3.4 STATISTICS

### 3.4.1 Survival analysis

Time to event data have a defined origin (such as date of returning from international military operations) to occurrence of an event (such as death, divorce, marriage, or violent crime).

The data are often illustrated using Kaplan-Meier curves, showing the cumulative incidence of the event of interest on the y-axis and the observation time on the x-axis. Using Cox regression, assuming proportional hazards, one or more variables can be analysed as predictors or adjustment factors for the event of interest. The Cox model estimates the hazard ratio (HR), that is the ratio of the instantaneous probability of an event occurring in a given period when comparing two groups.

In Study I-III, conditional Cox regression was used in which the Cox model was conditioned on the matching set, with each matching set consisting of one deployed military veteran and up to five matched comparators.

### 3.4.2 Meta-analysis

Meta-analytical methods are statistical methods for combining data from separate studies. Meta-analysis can be performed based on pooling of individual patients from independent studies (patient-level meta-analysis) or, more commonly, by pooling aggregated results from different studies, such as randomised controlled trials or cohort studies.

The technique assigns different weights to individual studies so that some studies exert more influence on the pooled summary measure compared with other studies. In meta-analysis there are two main statistical models used for estimating the pooled overall estimate, namely the fixed effects model and the random effects model. These models use different assumptions of the studies included in the meta-analysis, leading to different approaches with regards to weights assignment to the individual studies.

The random effects model, which was used in **Study IV**, is recommended when it cannot be assumed that all studies are estimating the same underlying effect size. It incorporates both within-study variability (variability between subjects within a study [the sampling error]) and between-study variability (variability between effects in different studies [true variation in study effect sizes]). The fixed effects model only accounts for within-study variability, meaning that under the fixed effects model the majority of the weights will be given to large studies, while small studies will be principally disregarded. In contrast, weight assignment will be more balanced under the random effects model, and not only dominated by large studies.

The observed variability between study estimates is termed heterogeneity, and is usually reported in meta-analyses using the  $I^2$  statistic (measured in %; 0%=no variability).

### 3.4.3 The standardised mortality ratio

The standardised mortality ratio (SMR) is a mortality index used to create a point of reference when investigating mortality by comparing a target population at hand, for example deployed military veterans, with the general population. It is the ratio between the expected and the observed number of deceased in the target population.

The expected number of deceased in the target population is the product of the standardised mortality rate in the population, usually retrieved from government statistics, and the number of people in the target population.

## 4 RESULTS

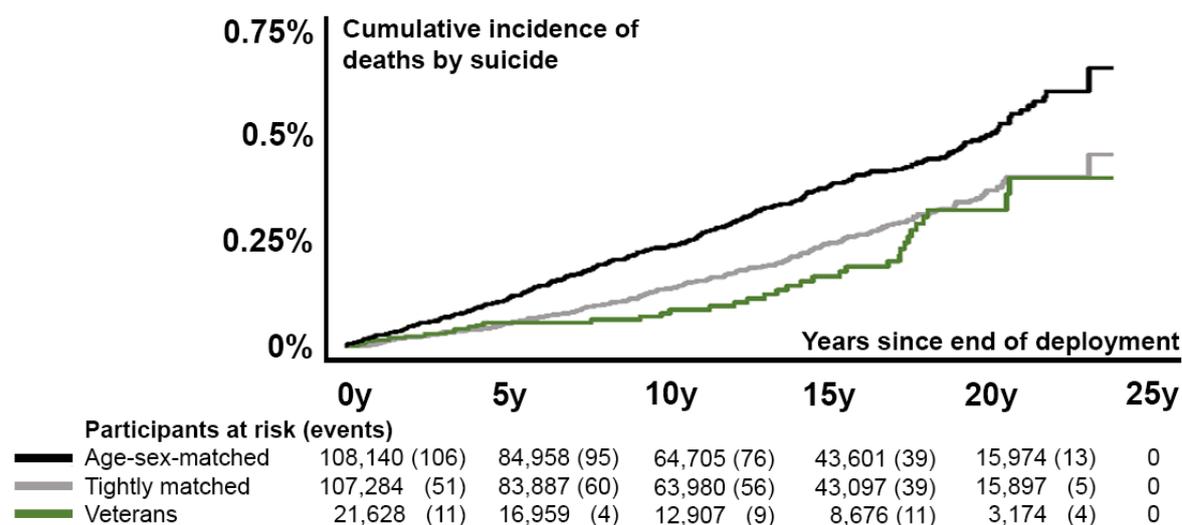
### 4.1 STUDY I: SUICIDE IN MILITARY VETERANS DEPLOYED 1990-2013

In this study 21,721 Swedish veterans with international military deployment sometime between 1990 and 2013 were included. The veterans were mostly men (97%) and the mean age at deployment was 27y.

Compared with the age- and sex-matched comparators, the veterans had higher scores on both the cognitive ability test and the psychological evaluation from the conscription tests (Figure 2), variables strongly related to suicide (Figure 3). The differences in cognitive ability and psychological assessment scores were eliminated by matching.

During a median follow-up of 12 years, 39 deaths by suicide occurred in the veteran population (15 suicides per 100,000 person-years). The corresponding incidence was 25 suicides per 100,000 person-years in the age- and sex-matched comparators, and 16 suicides per 100,000 person-years in the tightly matched comparator group (Figure 4).

The risk of suicide after deployment was lower in the veterans compared to the age- and sex-matched comparators (adjusted hazard ratio [aHR] 0.59; 95%CI 0.42-0.82), but no difference in suicide risk between the veterans and the tightly matched comparators could be observed (aHR 1.07; 95%CI 0.75-1.52). The results were similar for all-cause mortality.

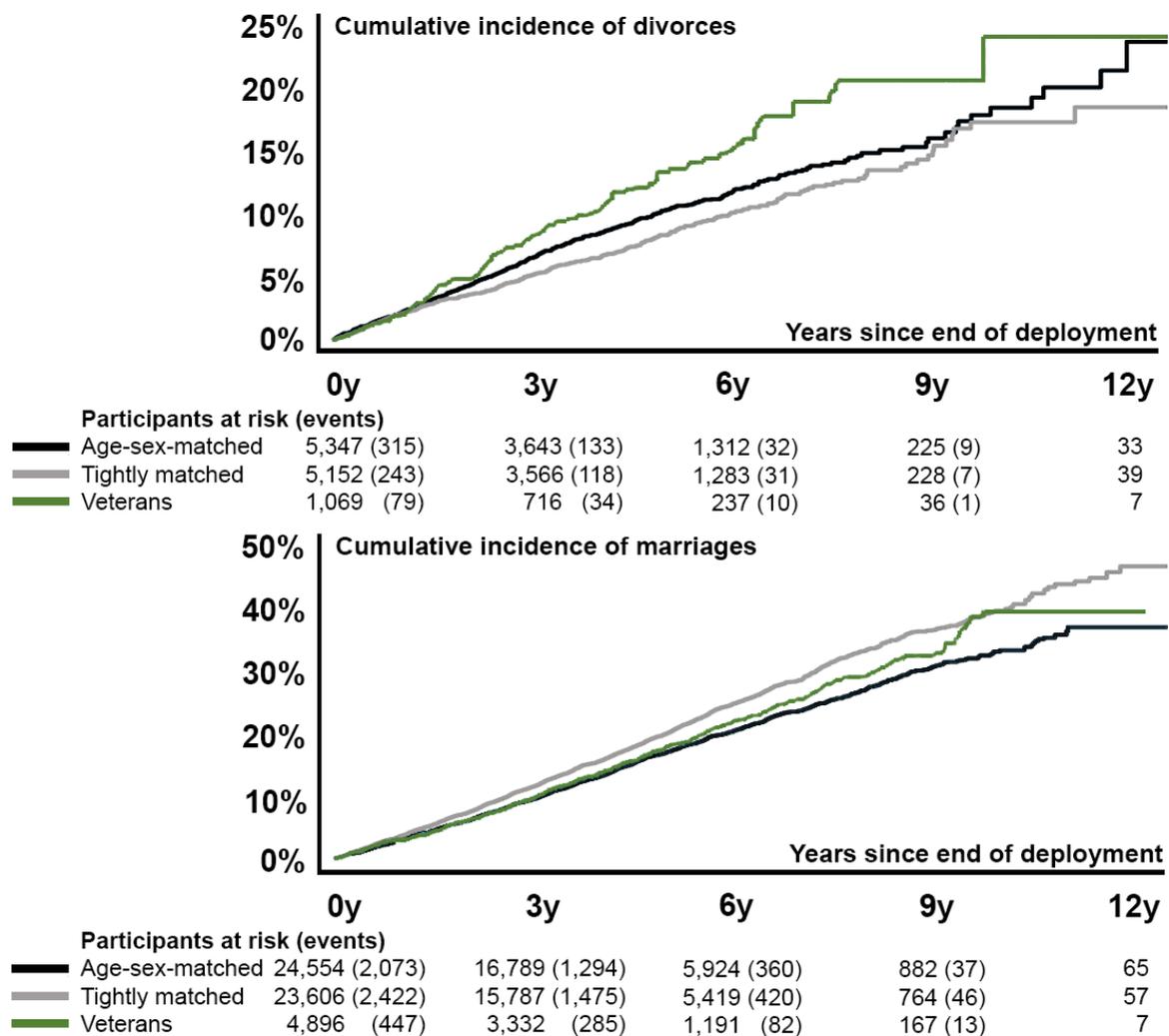


**Figure 4** Cumulative incidence of suicide among deployed military veterans and the two non-deployed matched comparator groups

## 4.2 STUDY II: MARRIAGE & DIVORCE AFTER DEPLOYMENT TO AFGHANISTAN

In this study, veterans who were deployed to Afghanistan sometime between 2002 and 2013 were included. After matching there were 1069 (18%) veterans who were married at the time of deployment. These married veterans were pre-dominantly men (99%) with a mean age at deployment of 40y. During a median 4.1 years of follow-up after return from deployment, the divorce rate was 277 versus 178 in deployed military veterans and tightly matched comparators, respectively (aHR 1.61, 95%CI 1.31-1.97; **Figure 5**).

At deployment, 4896 (82%) of the matched veterans were unmarried. These veterans were also mostly men (95%), but with a mean age at deployment of 27y they were younger than the married veterans. During a median 4.7 years of follow-up, the marriage rate was 399 versus 444 per 10,000 person-years in deployed military veterans and tightly matched comparators, respectively (aHR 0.89, 95%CI 0.83-0.96; Figure 5).

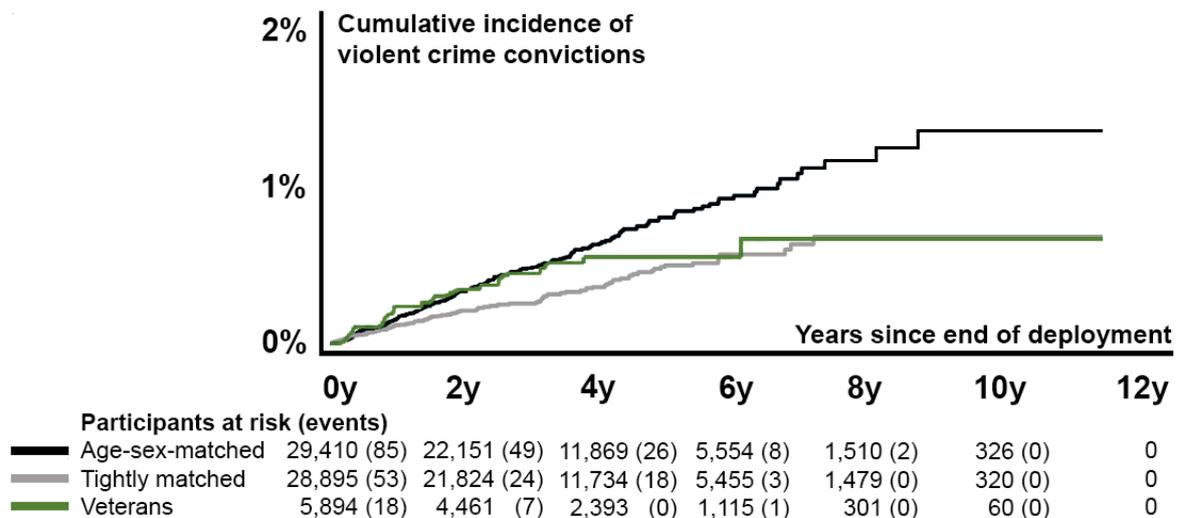


**Figure 5** Cumulative incidence of divorce (top) and marriage (bottom) among deployed military veterans and the two non-deployed matched comparator groups

### 4.3 STUDY III: VIOLENT CRIME AFTER DEPLOYMENT TO AFGHANISTAN

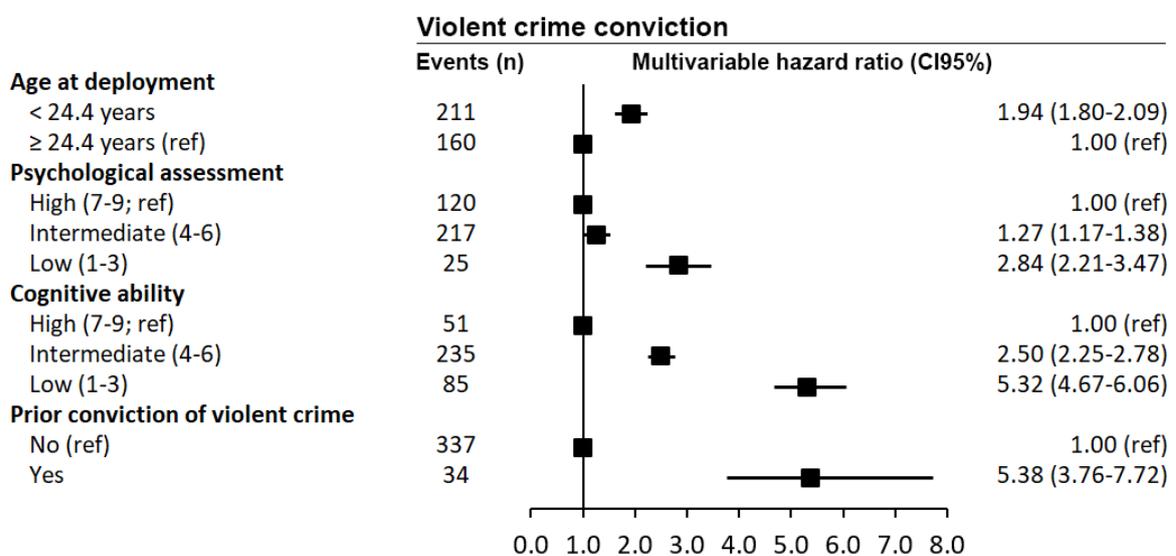
In this study 5894 matched veterans deployed to Afghanistan sometime between 2002 and 2013 and without any violent crime conviction before deployment were included. The veterans were pre-dominantly men (95%) with a mean age at deployment of 30y.

During a median follow-up of 3.6 years after return from deployment, 26 violent crime convictions were registered in the veteran population. No difference in rate of violent crime conviction could be detected in the veteran cohort compared with any of the matched comparator cohorts (12 versus 9 per 10,000 person-years [aHR 1.36, 95%CI 0.88-2.10] versus tightly matched comparators; 12 versus 16 per 10,000 person-years [aHR 0.85, 95%CI 0.56-1.29] versus age- and sex-matched comparators; **Figure 6**).



**Figure 6** Cumulative incidence of violent crime conviction among deployed military veterans and the two non-deployed matched comparator groups

Risk factors for a violent crime conviction among deployed Swedish military veterans were male sex, young age, a lower cognitive ability, a lower score on psychological evaluation and a history of violent crime (**Figure 7**).



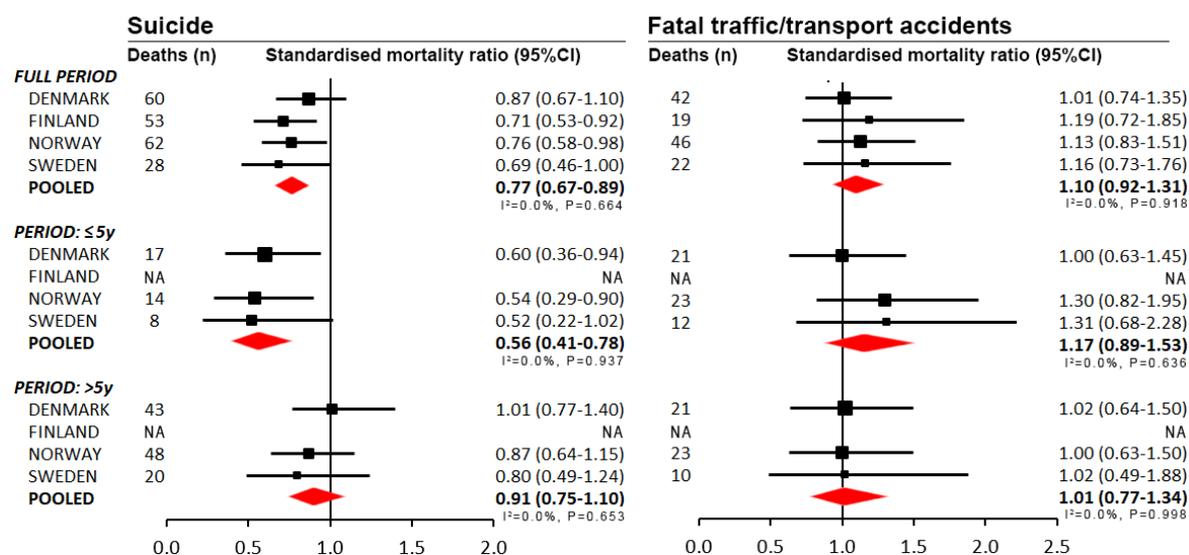
**Figure 7** Risk factor analysis of violent crime conviction among the deployed military veterans

#### 4.4 STUDY IV: MORTALITY IN DEPLOYED NORDIC MILITARY VETERANS

Between 1992 and 2010 (1990-2010 for Finland), a total of 27,442 Danish, 15,002 Finnish, 23,422 Norwegian and 17,718 Swedish military veterans were deployed, for a total of 83,584 Nordic military veterans.

Among the 83,584 veterans (mean age at deployment: 27y; 95% men) 1152 deaths occurred during follow-up (Denmark n=394; Finland n=212; Norway n=412; Sweden n=134) of which 343 were from external causes (including 203 suicides and 129 traffic/transport accidents), 134 cardiovascular deaths and 297 from neoplasms. Compared to the general population, veterans had a lower risk of death from any cause (pooled SMR 0.58, 95% CI 0.52-0.64), external causes (0.71, 95% CI 0.64-0.79), suicide (0.77, 95% CI 0.67-0.89), cardiovascular causes (0.54, 95% CI 0.46-0.64), and neoplasms (0.78, 95% CI 0.70-0.88).

No difference was observed regarding traffic/transport accidents for the whole period (1.10, 95% CI 0.75-1.10) but the pooled point estimate was elevated among veterans during the first 5 years after deployment (1.17, 95% CI 0.89-1.53) but not thereafter (1.01, 95% CI 0.77-1.34). For all other causes of death, except suicide, statistically significantly lower risk among veterans was observed both during the first 5 years and thereafter. For suicide, no difference was observed beyond the first 5 years (0.91, 95% CI 0.75-1.10; **Figure 8**).



**Figure 8** Forest plot of death by suicide (left) and fatal traffic/transport accidents (right) in military veterans from Denmark, Finland, Norway and Sweden compared to the general population. NA=not available.

## **5 METHODOLOGICAL CONSIDERATIONS**

### **5.1 REGISTER METHODOLOGY**

Register methodology harbours several advantages for epidemiological studies. Owing to the nationwide high-quality Swedish registers, the studies in this thesis included all those in the target population (except the few serving in the Special Forces and classified personnel) and followed them for up to more than 20 years after deployment regarding the outcomes.

This approach can be compared with questionnaire-based studies which typically suffer from initial large losses due to non-responders and then additional losses during follow-up. Moreover, outcomes such as dates of death, divorce, marriage and violent crime conviction are likely both more accurate and complete when retrieved via registers than via self-report.

The main limitation of register-based studies in epidemiological research is that the analyses are limited to the data available in the registers, which originally served another purpose. Regarding divorces, for example, this thesis could only investigate whether it had occurred or not, but could not shed light on the underlying reasons. In addition, register data carry the risk of misclassification. For example, fatal transport accidents may be intended suicides or indirect or covert forms of suicide, although other study designs are likely to share this limitation.

### **5.2 COMPARATOR GROUP**

The choice of a comparator group is a central methodological issue in studies of deployed military veterans. Some commonly used types are described below.

#### **5.2.1 General population**

Comparisons of veterans to the general population, which is the default comparison group choice in the scientific literature (commonly accounting for age and sex), are affected by the healthy soldier effect, that is the fact that individuals who qualify for international military deployment have gone through extensive physical and psychological testing. This rigorous procedure means that their baseline health, before deployment, is likely to be better than that of the unselected general population of the same age and sex.

#### **5.2.2 Before versus after**

An alternative would be to use the veterans as their own comparators in a before-after analysis, comparing the frequency of the outcomes before and after deployment in the same individual. A major limitation with this approach, however, is that age is confounding most (if not all) relevant outcomes. For instance, it would not be possible in a before-after analysis to distinguish a deployment-related increase in mental health problems from a similar age-related increase, given that both lead to an increase over time. Moreover, mortality outcomes would be impossible to study as the analysis is contingent on survival until deployment.

#### **5.2.3 Non-deployed military personnel**

Another alternative would be to use non-deployed veterans as comparators with deployed veterans, where the term “veteran” in this case would refer to an individual who has gone through all the tests to qualify for military deployment. This kind of approach would be possible in countries with large populations of full-time employed military personnel, and would avoid much of the bias introduced by the healthy soldier effect. However, another type of selection bias could affect these studies, namely what is referred to as “the healthy warrior effect”, that is the effect of the tendency to deploy only the mentally and physically most fit soldiers.<sup>84</sup>

#### **5.2.4 Era veterans**

A fourth alternative would be to use “era veterans”, that is veterans deployed to other conflict zones during the same period, as a comparison group. This approach would eliminate or reduce the healthy soldier effect and likely decrease the healthy warrior effect. The limitation of this approach is that it requires a large number of individuals simultaneously deployed to different conflict zones to reach statistical power. In addition, this approach is best suited to investigations of conflict-specific outcomes, such as whether there was a specific Gulf-War syndrome.<sup>85</sup>

#### **5.2.5 Randomisation**

Finally, to determine a causal relationship between exposures during military deployment and subsequent health problems would require randomisation of individuals to either military deployment or to a non-deployed comparison group. There are examples of veteran studies in which young Americans through a draft lottery were assigned to either deployment to Vietnam or not deployed, which in many ways is similar to a randomisation process.<sup>56,86</sup> For practical and ethical issues in Sweden, a comparable recruitment procedure would be difficult to perform. Moreover, the US lottery had some limitations in that many who were allocated not to deploy enlisted voluntarily, and many of those allocated to deployment were never deployed. This crossover in both directions contaminates the initially random allocation.

#### **5.2.6 Comparators in this thesis**

In the present research project, the unique opportunities provided by the rich data of high quality in the conscription register and health care registers were capitalised on to create a tightly matched comparison group consisting of individuals who had performed conscription tests but who had not been deployed abroad. Apart from matching these individuals to the deployed veterans on age and sex, which is standard in the scientific military veteran literature, they were matched on an array of variables associated with mental and physical health (for example cognitive ability, psychological assessment and history of mental health problems).

### **5.3 HEALTH-SEEKING BEHAVIOR**

The governmental report "A Swedish Veteran Policy, Part 1" (SOU 2007: 77) stipulated that military servicemen and women selected for deployment should not be suffering from serious chronic diseases or have some other health impairment. Although the report does not specify whether, or which, mental health problems constitute such a health impairment, previously deployed veterans may have incentives not to disclose mental health problems, if they intend to apply for further deployments.

It has been reported that US veterans from the recent wars in Iraq and Afghanistan are reluctant to seek help despite mental health problems.<sup>8</sup> A bias towards unreported cases in the Swedish veteran population is therefore possible. However, when studying hard outcomes, such as those in this thesis (mortality, violent crime conviction, marriage and divorce), under-reporting and reluctance to seek health care is probably of less concern.

## 6 ETHICAL CONSIDERATIONS

Specific ethical considerations apply to register-based studies. Although study participants are not exposed to any intervention that can result in direct physical harm, they raise questions about integrity given that large amounts of data are collected from several register sources.

Informed consent is generally required in medical research, but for most register-based studies such consent is not required by ethical review boards. It is seldom feasible to collect informed consent from several thousands or even several millions of individuals, and it is impossible to receive consent from deceased individuals (precluding studies of mortality and introducing selection bias in any study with longer follow-ups). Instead, safeguards are usually required to protect study participants from integrity-related harm. These preventive measures include the following: 1) all research data are de-identified prior to delivery, 2) results are only presented on an aggregated level (so that specific individuals cannot be identified) and 3) safe storage of data.

In practical terms, de-identification includes deletion of names, personal identity numbers, and usually the exact date of birth. However, despite these measures, it may still be possible to identify some of the participants. According to Swedish law, it is not necessary that all participants are identifiable, only that some are, for the data to be regarded as sensitive personal data.

There are integrity-related risks associated with register-based studies. With proper data handling and storage, these risks can be minimised, but not eliminated. Nevertheless, while there are risks, there are also many benefits, as large groups of people can be followed for long periods and be compared with the general population. Moreover, register-based studies offer the opportunity for more detailed matched comparators with little or no missing data. From an ethical perspective, the integrity-related risks must be weighed against the benefits of register-based studies.

There is also an economic dimension to register-based research in the sense that these studies provide high-quality data to a low cost in comparison with traditional follow-up studies. Hence, scarce economic resources for research can be used more efficiently, because research questions that are possible to answer via registers free up resources that can be invested in research questions that cannot.

The studies in this thesis were approved by the regional ethical review board in Stockholm, indicating that the board regarded the potential benefits of the research to outweigh the risks of real or perceived integrity breach.

## 7 INTERPRETATIONS & CONCLUSIONS

When this thesis was initiated, no large-scale epidemiologic study on health after military deployment abroad had been published for Swedish veterans who had served after 1999.<sup>1,87</sup> Meanwhile, studies from the US reported high levels of PTSD and suicide among military veterans from the wars in Afghanistan and Iraq.<sup>8,88</sup> Using high-quality nationwide registers, this thesis sheds light on some health and social outcomes among Swedish military veterans after relatively recent overseas military deployment, mainly to the Balkans and Afghanistan.

The results showed that the veterans constituted a healthy population before deployment compared with non-deployed age- and sex-matched comparators. This result was expected because military deployment is preceded by selection tests for both physical and mental health, and because only individuals who are currently healthy are deployed.

From a register-based viewpoint, the veterans as a group had continued good health also after deployment compared to the age- and sex-matched as well as tightly matched comparators. No association between military deployment and all-cause mortality or suicide after return from deployment was observed (**Study I**). Nor did the veterans appear to be more violent after deployment than non-deployed comparators, at least not in terms of violence leading to conviction (**Study III**).

The lower mortality observed in Swedish deployed veterans compared with the general population of the same age and sex was also observed in Denmark, Finland and Norway (**Study IV**). This lower mortality applied to several specific mortality causes (for example death from external, cardiovascular and cancer causes). In contrast, a higher rate (though not statistically significant) of fatal traffic/transport accidents among the veterans was observed during the first years after military deployment. Fatal traffic/transport accidents were uncommon and estimates associated with much uncertainty, despite pooling of data from four countries. Still, several large studies from other countries have reported an increased risk of fatal accidents and suicide among veterans the first years after deployment, but not thereafter.<sup>89,90</sup> Such higher risk of accidents may be linked to increased risk-taking behaviour just after returning home.<sup>48</sup>

Divorce was more common than in tightly matched comparators, and marriage was somewhat less frequent (**Study II**). Because the underlying data for this analysis did not include any information beyond the occurrence of these outcomes, we can only speculate on what the potential causes were. For instance, they could be due to mental health problems acquired during military deployment, but this argument is contradicted by the findings of no differences between deployed military personnel and non-deployed comparators regarding suicide (**Study I**), inpatient psychiatric care or psychiatric medication use (**Study III**).

The results from this thesis apply to military veterans in Sweden (**Study I-III**) and the Nordic countries (**Study IV**) as a group. Individual cases of severe illness after deployment exist, although they were less common than in the age- and sex-matched general population.

In conclusion, this thesis did not find an association in Swedish deployed veterans between international military deployment and death by suicide or violent crime conviction compared with non-deployed comparators who were similar on a number of relevant variables. However, the veterans had a higher probability of divorce and lower probability of marriage. In terms of mortality, Nordic military veterans were similar and had a consistently lower risk of death than the general population, except for fatal traffic/transport accidents where no difference was observed.

## **8 FUTURE PERSPECTIVES**

### **8.1 UNDER-EXPLORED OUTCOMES**

Many potential health and social outcomes after military deployment remain to be investigated using register-based studies regarding Swedish veterans. The present studies, and two early register-based studies on suicide and cancer, are just the first steps in this field by analysing mortality, cause-specific mortality, certain psychiatric outcomes, marriage, divorce and violent crime.<sup>1,75,87,91</sup> Short- and long-term cardiovascular effects, long-term cancer risks and some social outcomes (such as work loss, unemployment and earnings trajectories) remain to be investigated.

### **8.2 METHODOLOGICAL CHALLENGES**

In addition to yet unexplored outcomes, methodological challenges persist. Specifically, addressing and further reducing the healthy soldier effect is vital, as it is unlikely that large-scale randomised trials will ever be done in Sweden (randomising individuals to international deployment or to remaining at home). Matching or adjusting for additional variables, using different types of matching and exploring the merits of sibling designs are potential areas for future research.

### **8.3 QUESTIONNAIRE & INTERVIEW STUDIES**

Register-based studies have distinct strengths, but also recognised weaknesses. Complementing register-based studies with interview and questionnaire-based studies is often important to retrieve information not available in registers, as well as the possibility of gaining a better understanding of the mechanisms underlying register-based findings. For example, despite not observing greater psychiatric problems in deployed veterans compared with their tightly matched comparators, the veterans in our studies still had a more than 50% higher risk of divorce after deployment. Using questionnaires or interviews would permit an understanding of which underlying factors need to be studied, such as getting information about marital quality before deployment, who initiated the divorce, and why.

### **8.4 FUTURE AREAS OF STUDY**

Future studies need to focus on:

1. exploring further the impact of the healthy soldier effect
2. determining what is driving the higher risk of divorce in military veterans deployed abroad
3. exploring social outcomes beyond marriage/divorce and violent crime by analysing labour market outcomes such as sick leave, disability pension and income trajectories among deployed military veterans
4. investigating health outcomes among other personnel serving abroad on a regular basis but who are not in the military (for example the police and NGO volunteers)
5. capturing potential positive effects from military deployment abroad
6. revisiting Afghanistan veterans when longer follow-up is available
7. examining whether there are special issues for women in the military

## 9 ACKNOWLEDGEMENTS

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