



National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

**Suicide mortality
among deployed
male military
personnel
*compared
with men who were
not deployed***



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and the Environment
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Colophon

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This investigation has been performed by order and for the account of ministry of Defence.

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Synopsis

Suicide mortality among deployed male military personnel compared with men who were not deployed

In the US, reports have been published on high suicide rates among US military personnel after deployment to Iraq and Afghanistan. The National Institute for Public Health and the Environment (RIVM) studied whether this was also the case for Dutch male deployed military personnel. The study did not find indications of high suicide rates between 2004 and 2012 among deployed male military personnel. It cannot be ruled out that different results might be found if a different follow-up period, including other missions, were studied.

To gain more insight into the possible consequences of deployment for military personnel and how it affects their life, a different type of research is necessary. It is important to examine, amongst other things, which factors have an influence on the suicide cases. Further expanding the research questions to suicide attempts by military personnel might supplement the current findings.

The RIVM used data from over 40,000 Dutch male deployed military personnel. Since 2004, the Ministry of Defence has used a central register of military personnel. In this study, military personnel deployed for 30 consecutive days or more were examined. The number of military personnel that died between 2004 and 2012 and the causes of death were determined by using data from Statistics Netherlands. The rates of suicide mortality among deployed military personnel did not differ statistically significant compared with the rates of suicide among working Dutch men and military men who were not deployed or deployed for less than 30 days.

The Ministry of Defence asked the RIVM to perform this study because of the concern expressed by military personnel, the media and politicians.

Keywords: veterans, ministry of defence, deployment, suicide, military, cohort study

Publiekssamenvatting

Zelfdodingen onder Nederlandse mannelijke militairen die op missie zijn geweest vergeleken met mannen die niet op missie zijn geweest

In de Verenigde Staten zijn berichten verschenen dat militairen die naar Irak en Afghanistan zijn uitgezonden vaker zelfmoord plegen. Het RIVM heeft een eerste onderzoek gedaan naar de vraag of dat ook aan de orde is onder uitgezonden Nederlandse mannelijke militairen. Er zijn geen aanwijzingen gevonden dat de onderzochte uitgezonden Nederlandse militairen tussen 2004 en 2012 vaker zelfmoord hebben gepleegd. Het is niet uit te sluiten dat onderzoek over een andere periode met andere missies, andere uitkomsten kan geven.

Om meer inzicht te krijgen in de gevolgen van uitzending op militairen en hoe dat ingrijpt in hun leven is ander onderzoek nodig. Hiervoor is het onder andere van belang uit te zoeken welke factoren van invloed zijn geweest op zelfmoordgevallen die zich hebben voorgedaan. Ook zouden andere zaken onderzocht kunnen worden, zoals het aantal mislukte zelfdodingen.

Het RIVM baseert zijn bevindingen op gegevens van ruim 40.000 Nederlandse mannen die op (vredes)missies zijn uitgezonden; het ministerie van Defensie houdt deze gegevens sinds 2004 centraal en gestructureerd bij. In dit onderzoek is gekeken naar militairen die langer dan 30 dagen zijn uitgezonden. Het aantal militairen dat tussen 2004 en 2012 is overleden en de doodsoorzaken zijn herleid door de gegevens van Defensie te koppelen aan de registratie van doodsoorzaken van het Centraal Bureau voor de Statistiek (CBS). De mate waarin zelfdoding voorkomt onder militairen die op missie zijn geweest, verschilde niet statistisch significant van de mate waarin dat voorkomt onder werkende Nederlandse mannen en mannelijke militairen die niet of korter dan 30 dagen zijn uitgezonden.

Het onderzoek is op verzoek van het ministerie van Defensie uitgevoerd naar aanleiding van de zorg over dit onderwerp onder militairen, in de media en de politiek.

Kernwoorden: veteranen, defensie, uitzending, suicide, zelfmoord, militairen, cohortonderzoek

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Summary

Background

Reports on high suicide rates among US military personnel have raised a lot of media, political and academic attention. Concern has also been raised in the Netherlands about whether the deployment of military personnel is associated with an increased risk of suicide. To examine whether the suicide mortality rate is different among Dutch deployed military personnel than among the general Dutch population, the Dutch Ministry of Defence asked the Dutch National Institute for Public Health and the Environment (RIVM) to perform the current epidemiological study. The first objective of this study was to describe the total mortality rate and suicide mortality rate amongst veterans (defined in this study as military personnel who were deployed for at least 30 consecutive days). The second objective was to examine how these rates compared with the total mortality and suicide mortality rates in the general Dutch population. Suicide rates among veterans were additionally compared with non-veterans (defined in this study as military personnel who had never been deployed or had been deployed for less than 30 consecutive days). It was not examined whether deployment was the cause of suicide. The third objective was to examine whether suicide mortality rates differed depending on the missions on which military personnel had been deployed to.

Methods

A historical (i.e. retrospective) cohort study was performed in which Dutch male veterans (n=40,444), an age-matched random selection of the general Dutch male working population (the 'general working population'; n=165,154) and Dutch non-veterans (n=33,364) were examined. In this study, veterans were defined as military personnel who had been deployed for at least 30 consecutive days. This minimum period was chosen to ensure that specialists, suppliers and other personnel who were deployed for working visits were not considered as deployment. Non-veterans were examined as a control group. Only men were included in the study because the number of female personnel was relatively small and suicide mortality among women was too low to perform analyses with sufficient statistical power.

Anonymised data from the Ministry of Defence on military personnel (veterans and non-veterans) who were in service between 2004 and 2012 was used. Therefore, military personnel who were already in service before 1-1-2004 and were still in service on 1-1-2004 were also included. Data sets from Statistics Netherlands were used to select the random sample of the general working population and to retrieve data on the general working population and military personnel, for instance relating to receipt of social security benefits and cause-specific mortality. Crude suicide incidence rates were calculated to describe suicide mortality among the veterans and comparison groups. Cox regression analyses were performed to compare (total and suicide) mortality between the veterans and the comparison groups. Adjustments were made for age, rank (only in comparisons with non-veterans and as a proxy for socioeconomic status) and receipt of social security benefits (i.e. unemployment benefits, disability benefits or other social benefits).

Results

During the follow-up time of nine years in the period 2004–2012, 22 of the 40,444 male veterans (8.0 per 100,000 person-years), 156 of the 165,154 males from the general working population (i.e. an age-matched sample of the general Dutch male working population; 11.4 per 100,000 person-years) and 27 of the 33,364 male non-veterans (11.2 per 100,000 person-years) committed suicide. For mortality from all causes, the numbers of deaths were 252 for veterans, 1,388 for the general working population and 199 for non-veterans. Cox regression analyses that took into account age, rank and changes during the follow-up period in receipt of social security benefits showed that total and suicide mortality rates in the veterans group were not significantly different from total and suicide mortality rates in the general working population and in non-veterans groups. Nor was the number and duration of deployments associated with either total or suicide mortality when veterans were compared with the general working population or with non-veterans. The question whether suicide mortality rates differed between missions could not be answered because the relatively rare occurrences of suicide precluded a valid statistical comparison between missions.

Discussion

This is the first study specifically on suicide mortality among Dutch deployed military personnel. The scope of the study and its conclusions are limited to post-deployment (suicide) mortality during 2004–2012 in the group of veterans in service on or after 1-1-2004. The findings can therefore not be generalised to other periods, all missions and other definitions of veterans. This epidemiological study was designed to examine numbers of suicide among veterans as a group. To understand why men committed suicide and if and how their suicides were influenced by previous deployment, interviews with relatives, colleagues, employers and caregivers as well as an examination of personnel and medical files (i.e. a qualitative research method) may be a suitable method.

Only suicide mortality was studied; for a broader view on how veterans experienced their missions, future studies may expand the current research by also examining suicide attempts by military personnel.

Conclusion

This epidemiological study does not, for the Dutch situation, confirm reports from the US of higher suicide rates among deployed military personnel. There were no indications that suicide mortality rates in the period 2004–2012 among veterans deployed for more than 30 consecutive days exceeds the suicide mortality rates in the general working population or among non-veterans. It cannot be ruled out that different results might be found if a different follow-up period, including other missions, were studied.

1 Introduction

1.1 Background

Reports on high suicide rates among US military personnel after deployment to Iraq and Afghanistan (Kuehn, 2009; Lineberry and O'Connor, 2012) raised a lot of media, political and academic attention (e.g. Thompson and Gibbs, 2012). Concern has also been raised in other countries, including the Netherlands (e.g. De Pers, 2012), about whether the deployment of military personnel is associated with an increased risk of suicide. To examine whether the suicide mortality rate is different among Dutch deployed military personnel than among the general Dutch population, the Dutch Ministry of Defence asked the Dutch National Institute for Public Health and the Environment (RIVM) to perform the current epidemiological study.

1.2 Objectives

The first objective of this study was to describe the total mortality rate and suicide mortality rate amongst veterans based on mortality registry data from Statistics Netherlands (in Dutch: Centraal Bureau voor de Statistiek; CBS). The second objective was to examine how these rates compared with the total mortality and suicide mortality rates among the general Dutch population. Suicide rates among veterans were additionally compared with suicide rates in non-veterans (i.e. military personnel not deployed or deployed for less than 30 consecutive days). It was not examined whether deployment was the cause of suicide. The third objective was to examine whether suicide mortality rates differed depending on the missions on which military personnel had been deployed to.

1.3 Organization of this report

Chapter 1 provides an introduction with a brief overview of the epidemiological evidence on the possible association between deployment and suicide, on the incidence of suicide in the general Dutch population and on risk factors of suicide. In Chapter 2, the methods of this study are described, including the study design, study population and data analyses. The results are described in Chapter 3 and discussed in Chapter 4.

1.4 Previous epidemiological studies on suicide among deployed military personnel

Most studies on the association of deployment with suicide have been performed among US military personnel. Epidemiological studies found inconsistent results. Based on crude suicide rates, high suicide mortality rates among US military personnel deployed to Iraq and Afghanistan were reported (Kuehn, 2009; Lineberry and O'Connor, 2012), whereas other studies reported no difference in risk of suicide between US military personnel deployed to Iraq or Afghanistan and non-deployed military personnel (LeardMann et al., 2013; Reger et al., 2015). One study examined only military personnel and observed an increase among suicides during military service among all military personnel,

whether currently, previously as well as never deployed, over time (i.e. between 2004 and 2009; Schoenbaum et al., 2014). The authors of this study argue that the fact that this increasing time trend is found in all groups suggests that suicide is not necessarily related to deployment. Kang and Bullman (2009) draw similar conclusions in their review of the literature; they report that, although suicide numbers seem to be increasing over time among military personnel, a relationship between deployment and risk of suicide has not been observed. In line with this notion, Kang and colleagues (2015) observed a higher risk of suicide after no longer being in service among military personnel deployed to Iraq or Afghanistan as well as among non-deployed military personnel compared to the general US population. In comparison with non-deployed military personnel, after adjusting for age, gender, race, marital status, branch of service and rank, deployed military personnel showed a lower risk of suicide after leaving service (Kang et al., 2015). This suggests that the higher suicide rates found among those deployed to Iraq or Afghanistan may not have been the result of deployment itself.

The suicide risks of US military personnel deployed in earlier conflicts (e.g. the Vietnam War) were also examined. Again, conflicting results were found, showing either a higher risk of suicide (Boehmer et al., 2004; Bullman and Kang, 1996; Kaplan et al., 2007) or no significant difference in risk among deployed compared to non-deployed military personnel (Miller et al., 2009, 2012).

Studies were also performed amongst military from other countries than the US, again showing inconsistent results. Macfarlane and colleagues (2000) found that suicide occurred approximately equally among UK Gulf War veterans and military personnel who were in service during the Gulf War (which ended in 1991) but were not deployed to the Gulf War. In one systematic review, the authors observed a higher injury-related mortality (including suicide) in veterans from the US, the UK and Australia who served during the Vietnam or Gulf Wars than among those who did not, and much of the excess injury-related mortality was found to be associated with motor vehicle events (Knapik et al., 2009). In another systematic review, Sareen and colleagues (2010) focused on the association between peacekeeping missions and suicide risk among military personnel from various countries (including US, Sweden and the UK) and found inconsistent results (Sareen et al., 2010). In the cases where an increased risk of suicide after deployment was observed, the association was relatively weak (Sareen et al., 2010).

Very few studies have been performed on suicide rates among Dutch military personnel. A study on Balkans veterans, which in contrast to the present study included conscripts, showed that 31 (0.17%) of 18,175 male military personnel deployed to the Balkans and 140 (0.10%) of 135,355 male personnel not deployed to the Balkans (of whom 1% had been deployed, but to other areas) died by suicide between 1993 and 2008. The risk of suicide was not significantly different among the Balkans-deployed group compared with the non-Balkan deployed group. Compared with the general male age-matched Dutch population, the risk of suicide among male Balkans veterans was not statistically significantly different either (Schram-Bijkerk and Bogers, 2011). Note that this study used mortality data from Statistics Netherlands, which is the only systematic and most complete registry of suicides of all inhabitants of the Netherlands.

1.5 Incidence of suicide in the Netherlands

From an epidemiological point of view, suicide is a rare event, which makes it difficult to examine due to its low statistical power. Still, the impact of suicide is huge and means an enormous tragedy for the people left behind. In 2013, 1,854 people from the general Dutch population (i.e. over 16 million inhabitants) died from suicide (CBS, 2014). Adjusted according to the fluctuations in gender and age of the Dutch population over the years, the rate of suicide among the Dutch population in 2013 was 11 per 100,000 inhabitants. Fewer women (7 per 100,000) than men (16 per 100,000) died by suicide. Suicide rates also differed by age group. For instance, 3 per 100,000 Dutch 10–19-year-olds and 18 per 100,000 Dutch 50–64-year-olds died by suicide in 2013 (CBS, 2014).

1.6 Risk factors for suicide

In the Netherlands, suicides are more prevalent among unemployed individuals (Stam and Hertog, 2013; Gilissen et al., 2013), among lower educated individuals (Stam and Hertog, 2013) and among individuals without a partner (Gilissen et al., 2013; Stam and Hertog, 2013). Bush and colleagues (2013) have also observed that a relatively large percentage of the US soldiers who committed or attempted suicide had a history of a failed spousal or other intimate relationship (51% of actual suicides and 51% of attempted suicides). Stam and Hertog (2013) provide an overview of the determinants of suicide, which may be divided into three groups: personal factors (e.g. mental illness, previous suicide attempts and life events), lifestyle (e.g. alcohol abuse) and environmental factors that may facilitate suicide (e.g. the presence of high buildings or railway lines), which may be more prevalent in but are not limited to the risk groups mentioned above (Stam and Hertog, 2013). The risk factors for suicide among military personnel include separation from a partner or spouse (Bush et al., 2013), a poor financial situation before deployment, an unhappy childhood, undertaking pointless tasks during deployment (Ejdesgaard et al., 2015) and mental disorders (e.g. substance abuse, schizophrenia, mood disorders; Ejdesgaard et al., 2015; Harris E. C. and Barraclough, 1997). Although it is relevant to identify risk factors of suicide among Dutch veterans, the objectives of the current study were not to examine the causes of suicide, but merely to describe suicide mortality rates among veterans and to compare those with suicide mortality rates among the general Dutch population and non-veterans. Therefore, such risk factors were not examined in the current study.

One important difference between military personnel who are in service and the general Dutch population is that military personnel who are in service are by definition employed while members of the general Dutch population are not necessarily employed. Specifically unemployment has been shown to be predictive of suicide in the Netherlands (Stam and Hertog, 2013) as well as in other countries (e.g. Qin et al., 2003; Wanberg, 2012). A study from the Netherlands showed that members of the general Dutch population receiving social security benefits (which included unemployment benefits but also disability and welfare benefits) are at higher risk of committing suicide (Gilissen et al., 2013; Qin et al., 2003; Wanberg, 2012). Therefore, whether the individuals under study

were receiving social security benefits was taken into account in the current study.

2 Method

2.1 Study population

A historical (i.e. retrospective) cohort study was performed in which Dutch male veterans, an age-matched random selection of the general Dutch male working population (the 'general working population') and Dutch non-veterans were examined. A brief description of the selection of the analytic sample is given below (see Appendix 1 for a detailed description of the selection of the analytic sample).

Veterans and non-veterans

Veterans were defined in the current study as military personnel who had been deployed for at least 30 consecutive days. This minimum period was chosen to ensure that specialists, suppliers and other personnel who were deployed for working visits were not considered as deployed. Non-veterans were military personnel who had never been deployed or had been deployed for less than 30 consecutive days. Non-veterans were used in the analyses as a control group.

Although the Ministry of Defence has data on (deployment of) military personnel who left service before 1-1-2004, it has yet to be validated and was therefore not readily available. Data on military personnel is stored by the Ministry of Defence in a central digital registry of military personnel called 'PeopleSoft' (Hardij and Leenstra, 2012). PeopleSoft became operational in 2004. Data personnel (still) in service from 1-1-2004 onwards has been validated and is therefore reliable, complete and readily available. For this group of personnel, all data was validated, including data from before 2004. Therefore, for this study, anonymised data on veterans and non-veterans who were registered in PeopleSoft on or after 1-1-2004 was used (see section 2.3). The veterans and non-veterans thus included personnel who entered the military before 2004 and were still in service at 1-1-2004 and personnel who entered the military on or after 1-1-2004.

The group of veterans was restricted to people who were:

- Professional military personnel, militarised civilian personnel or reservists;
- In service at any time between 1-1-2004 and 31-12-2012;
- Male. Women were excluded from the analyses because the number of female personnel was small and fewer than 10 female veterans had died by suicide during this period, a number that was too small to allow meaningful analyses. (For reasons of privacy, Statistics Netherlands does not always allow numbers below 10 to be reported, as information about individuals may be disclosed.) ;
- At least 17 years old on entry into service (the legal minimum age at which individuals may enter service);
- Deployed on a single deployment for 30 consecutive days or more at least once (before or after 1-1-2004). The first such deployment was counted as their first deployment for the purpose of this study, irrespective of the number and cumulative duration of previous or subsequent deployments.;

- At least 18 years old when they departed on their first deployment.

The group of non-veterans was restricted to people who were:

- Professional military personnel;
- In service at any time between 1-1-2004 and 31-12-2012;
- Male;
- At least 17 years old on entry into service;
- Not deployed or deployed for less than 30 consecutive days on a single deployment before 31-12-2012.

The general working population

To ensure that individuals in the random sample of the general working population were of approximately the same age as the veterans and were not receiving social security benefits on the day of entry into the study population (as it was a priori assumed and confirmed that most military personnel were not receiving social security benefits at entry into the study), group matching was used. For each veteran, four men from the general working population who were not receiving social security benefits and were not already included in the veteran and non-veteran samples were randomly selected. This was done for each year of entry into service of veterans (i.e. 2004 through 2011; no military personnel entered service in 2012 and also returned from a deployment of 30 consecutive days before 31-12-2012), per age group of approximately 5 years. In summary, the random sample was restricted to people who were:

- Male;
- Of approximately the same age as veterans;
- Not receiving social security benefits on the first day of entry into the cohort of their matched veteran;
- Not included in the study sample of veterans and non-veterans.

2.2 Data sources

As mentioned, for military personnel anonymized data from the Dutch Defence personnel system PeopleSoft was used. This human resource management system contains details about appointments, functions and deployments, as well as general information such as date of birth and rank. Data sets from Statistics Netherlands were used to select the random sample of the general working population and data about age, gender (from the Municipal personal records database (in Dutch: Gemeentelijke Basisadministratie voor persoonsgegevens; GBA)), emigration, receipt of social benefits (in Dutch: Sociaal Economische Categorie van personen in een bepaalde maand; SECMBUS) and cause-specific mortality (in Dutch: doodsoorzakenstatistiek). For more information, see cbs.nl.

2.3 Data collection

The information needed for the current study included:

- Deployments before and after 1-1-2004, including start and end dates of deployments, and mission;
- Dates of entry and termination of service;
- Last known rank;
- Gender;

- Month and year of birth;
- Personal ID numbers (in Dutch: Burger Service Nummer; for data linkage purposes only).

Additional data were retrieved by the department of Human Resources, such as military branch, but were not needed in the current study. The data was collected from PeopleSoft by the department of Human Resources (in Dutch: DienstenCentrum Human Resources). If necessary, data on post-active personnel (i.e. no longer in service) was supplemented by the Veteran Registration System (VRS).

As personal ID numbers were needed to link to data from Statistics Netherlands, a privacy impact assessment (PIA) was performed by the Ministry of Defence. The PIA is a government tool designed to reveal privacy risks in the creation of data sets. The handling of the personal data complied with the Personal Data Protection Act (in Dutch: 'Wet Bescherming Persoonsgegevens' (WBP)). A completed PIA is used to determine whether a study needs to be reported and approved before data can be used. The approval was stored in a registry of the Ministry of Defence.

Only after approval was the collected data made available to Statistics Netherlands. First, Statistics Netherlands recoded the personal ID numbers into Statistics Netherlands specific identification numbers (RIN). Second, according to these RIN the data was matched to the data from Statistics Netherlands (e.g. mortality data). Matching with the registries of Statistics Netherlands followed Statistics Netherlands privacy policy. Analysis of this data was done using Statistics Netherlands hardware, which was accessible only to two researchers of RIVM via a Remote Access System using fingerprinting. The researchers of the RIVM did not have access to the personal data. Only anonymous data was used.

2.4 Variables

Age, gender and emigration data

The age of all examined individuals included in the study were determined using their month and year of birth (for privacy reasons, the day of birth was not available to the researchers). For veterans and non-veterans, both age and gender were determined using data from PeopleSoft and for the general working population using data from Statistics Netherlands. Whether individuals had emigrated between 1-1-2004 and 31-12-2012 was determined by using data from Statistics Netherlands for veterans, non-veterans and the general working population.

Deployment dates

The deployment dates used for the current study were the start and end dates of all deployments, including deployments that started before 1-1-2004.

Last rank

The last rank (which in practice equates to the highest rank attained) was identified. Rank was categorised as (1) non-commissioned officer (NCO) and officer (in Dutch: onderofficier en officier), (2) soldier (in Dutch: soldaat) and (3) corporal (in Dutch: korporaal). Although rank is

categorised differently in the Navy from the other military services (Army, Military Police and Air Force). Because the branch of military service was not known for non-veterans, it was chosen to use the categorization used in the Army, Air Force and Military Police for all non-veterans. For the sake of comparability with non-veterans, the same categorization (used in the Army, Military Police and Air Force) was also used for all veterans, including those from the Navy.

Receipt of social security benefits

Because previous studies showed that those who were receiving social security benefits are at greater risk of committing suicide (e.g. Gilissen et al., 2013), and because Statistics Netherlands has information on receipt of social security benefits, this information was included in the analyses. It was determined whether veterans, the general working population and non-veterans had received social security benefits between 2004 and 2012 using data from Statistics Netherlands, which identifies the major source of income of individuals. Those receiving unemployment benefit, disability benefit or other social benefits were categorised as receiving social security benefits. Those recorded as 'employees', 'director-major shareholders', 'self-employed', 'having income from other work', 'not yet in school/ students with income', 'not yet in school/ students without an income', 'others without an income' or 'in receipt of a retirement pension' were categorised as not receiving social security benefits.

Cause-specific mortality data

Cause-specific mortality data from Statistics Netherlands between 1-1-2004 and 31-12-2012 was used. Statistics Netherlands obtains mortality data through an obligatory reporting system in the Netherlands, through which the treating doctor or the municipal coroner of a deceased person is obligated to send a cause of death form (B-statement) to the Register of Births, Marriages and Deaths of the municipality where the death occurred. This is then sent directly to Statistics Netherlands, since the B-statement is collected for statistical purposes only. The causes of death recorded in the B-statement are translated into codes according to the International Classification of Diseases (ICD-10) of the World Health Organization (WHO). When the cause is not coded properly, written or telephone enquiries are made by Statistics Netherlands (for more information, see <http://www.cbs.nl/nl-NL/menu/methoden/dataverzameling/doodsoorzakenstatistiek.htm>). In this study, causes of death were grouped in two groups: all causes (including suicide) and suicide (ICD-10 codes X60 – X84).

Cause-specific mortality data on military personnel who died during deployment

Statistics Netherlands receives information about whether military personnel died during deployment, but does not necessarily receive information on the cause of such deaths. In some cases, information may reach Statistics Netherlands that military personnel have died from a particular cause during a mission abroad (e.g. from acts of war). Statistics Netherlands then registers this cause of death. Nonetheless, the data on cause of death during deployment is possibly incomplete.

2.5 Data analyses

Descriptive statistics were calculated to describe characteristics of the study population. Numbers of (suicide) deaths were determined and crude suicide incidence rates were calculated to describe mortality among the veteran and comparison groups. Cox regression analyses were performed to compare mortality between the veteran and comparison groups (see section 1.2). In the Cox regression analyses adjustments can be made for covariates.

Standardized Mortality Ratio's (SMRs) were also calculated because, if necessary, comparisons can be made with previous studies that also calculated SMRs. However, a limitation of SMRs is that adjustments for confounding variables cannot be made. Also, SMRs are based on mortality figures from the general (male) population, whereas in the Cox regression analysis a more suitable comparison group of working men was used. Therefore, conclusions will be based on results from the Cox regression analyses, and SMRs are presented as supplementary information in Appendix 2.

Crude suicide incidence rates

Crude suicide incidence rates were computed by dividing observed suicide numbers by the number of person-years they were at risk of dying and expressed as incident cases per 100.000 person-years. For veterans, the person-years were counted from the return from the first 30-plus-day deployment. If the first deployment took place before 1-1-2004 and the individual was still in military service on 1-1-2004, the individual was considered to have been exposed from 1-1-2004. The person-years between entry into the study (i.e. 1-1-2004 or later) and the start of the first deployment of veterans were counted as the person-years for the controls (non-veterans and the general working population) because during that time the veterans were not yet considered to be exposed. The person-years during the first deployment (if it occurred after 1-1-2004) were excluded because veterans were considered to be exposed only after the first deployment; the time during deployment should therefore not be counted as time belonging to the control group either. For all individuals in the study, person-years were counted until the date of death, emigration or the end of the study (1-1-2013).

Cox regression analyses

The general working population and non-veterans were included as control groups. Age (in days) was defined as the follow-up variable, which is the variable that defines time under study. Time under study started at the beginning of the follow-up period (1-1-2004) or (for veterans and non-veterans) at entrance into the military if this was after 1-1-2004. For the general working population, time under study started on the approximate date of entry of the veterans they were matched to (i.e. the reference date, between 1-1-2004 and 1-1-2013). For all individuals in the study, time under study ended on the date of death, emigration or the end of the follow-up period (1-1-2013). Individuals who had emigrated were censored because mortality data from Statistics Netherlands are incomplete for individuals (military or not) who emigrated.

The Cox regression analyses were adjusted for age because suicide rates differ by age (CBS, 2014). This was done by using age as the time scale. In addition, analyses were stratified according to age at the start of the follow-up (in years). This controls for birth cohort effects, but also simulates a 'late-entry model', which accounts for the facts that not all examined individuals enter the study on 1-1-2004. Adjustments were also made for changes in receipt of social security benefits between 2004 and 2012 and, as a crude indicator of socioeconomic status for military personnel, last rank. This was done by including receipt of social security benefits and rank in the model. Adjustments for last rank were only possible when the control group consisted of non-veterans and not when the control group consisted of the general working population. Exposure was examined in three ways, in both the Cox regression analyses and the SMRs: after first deployment (the person-years were calculated as described above); in relation to the total number of deployments; and in relation to the total duration of all deployments (in days). The total number of deployments and the total duration of deployments in days were each divided into two categories: one deployment vs. two or more deployments; and 30–190 days vs. 191 or more days, respectively. This was done to avoid using numbers of suicides which might be below 10. The determination of exposure and the calculation of person-years for both the Cox regression analyses and the SMRs are explained in detail in Appendix 3.

Standardised Mortality Ratios (SMR)

To determine expected total and suicide mortality numbers among veterans and non-veterans, cause-specific mortality data from the general male population of comparable age from Statistics Netherlands was used. These expected numbers were used to calculate standardised mortality ratios (SMRs).

The computational programme for the calculation of SMRs was developed by the Netherlands Cancer Institute, and has been described previously (van Leeuwen et al., 1994). By using the person-year method, the expected number of deaths was computed, based on cause-specific mortality data from the general population, stratified by age (5-year periods), gender (only men were studied) and time period (3-year periods). For individuals who had emigrated, person-years from the date of emigration were excluded, because mortality data from Statistics Netherlands are incomplete for all individuals (military or not) who have emigrated. The SMRs were computed by dividing the observed numbers of deaths by the expected numbers. Confidence intervals were calculated using the Poisson distribution.

Sensitivity analyses

The Cox regression analyses were redone with the following alterations (i.e. sensitivity analyses):

- 1) Veterans who were deployed before 1-1-2004 were excluded to determine whether already being exposed on entering the study affected the results.
- 2) As opposed to the main analyses, where, in the veteran category, time during the first deployment was excluded and time during subsequent deployment(s) was counted, a sensitivity analysis was done in which time during subsequent deployments was also excluded. This analysis checked whether excluding deaths during

subsequent deployments affected the results. The reason for this analysis was that although deaths during the deployment of military personnel are systematically recorded by Statistics Netherlands, the cause of death is not.

- 3) All the main analyses were adjusted for last rank. In a sensitivity analysis, all Cox regression analyses with control groups of non-veterans were also stratified according to last rank, i.e. for each rank group a separate regression analysis was done. This was done because the strength of a possible association between deployment and (suicide) mortality might differ depending on last known rank. However, the numbers of individuals that committed suicide per rank category was too small to produce reliable results. Therefore, the results of this sensitivity analysis should be interpreted with caution.
- 4) Finally, all Cox regression analyses were adjusted for calendar year to examine whether time trends in death and suicide numbers (e.g. due to the economic crisis) affected the results.

3 Results

3.1 Characteristics of the study population

At entry into the study, the median age of veterans was approximately the same as the general working population but higher than that of non-veterans (see Table 1). The majority of all the individuals studied never emigrated. On the date of study exit (i.e. censoring), 7.0% of the general working population, 2.3% of veterans and 3.7% of non-veterans were receiving social security benefits. The last rank of the majority of veterans was (non-commissioned) officer and the last rank of the majority of non-veterans was soldier. A larger percentage of the non-veterans (55.4%) than the veterans (33.6%) were not in military service on the date of study exit.

The majority of deployed military personnel returned from their first deployment between the ages of 18 and 30 years and 44.3% were deployed on only one deployment (see Table 2). The median duration of the first deployment was 136 days and the median total duration of all deployments was 201 days. The duration of all deployments together was 191 days or more for 53.2% of the veterans. Of all the veterans studied, 45.7% had returned from their first deployment after 1-1-2004 and 43.0% had departed for their first deployment after 1-1-2004. The median time between return from first deployment (before or after 1-1-2004) and study exit was 9.2 years. The median time between return from last deployment (before or after 1-1-2004) and study exit was 5.0 years.

Table 1. Characteristics of a random selection of the general working population, veterans and non-veterans

	General working population n=165,154	Veterans n=40,444	Non-veterans n=33,364
Age at study entry, median [25–75 percentile]	27.0 [21–39]	28.0 [21–39]	20.0 [18–26]
Emigrated between 1-1-2004 and 31-12-2012, n (%)			
Never	149,485 (90.5%)	37,069 (91.7%)	30,709 (92.0%)
Once or more than once	15,669 (9.5%)	3,375 (8.3%)	2,655 (8.0%)
Receiving social security benefits on study exit, n (%)			
No	153,077 (93.0%)	39,323 (97.7%)	32,028 (96.3%)
Yes (Unemployment, welfare, disability)	11,528 (7.0%)	913 (2.3%)	1,231 (3.7%)
Information is lacking	549	208	105
Last rank, n (%)			
Soldier	/	4,671 (11.6%)	15,492 (46.4%)
Corporal	/	8,429 (20.8%)	5,199 (15.6%)
(Non-commissioned) Officer	/	27,344 (67.6%)	12,673 (38.0%)
Not in military service on study exit, n (%)		13,594 (33.6%)	18,140 (55.4%)
Study entry = Date of entry into the study. Study exit = Date of exit out of the study (i.e. date of censoring).			

Table 2. Deployment characteristics of veterans

	Veterans n=40,444
Age at return from 1 st deployment, n (%)	
18–30 years	27,735 (68.6%)
31–45 years	10,310 (25.5%)
46–60 years	2,399 (5.9%)
Total number of deployments, n (%)	
1	17,924 (44.3%)
2	11,006 (27.2%)
3	6,079 (15.0%)
4	2,994 (7.4%)
5	1,370 (3.4%)
6	641 (1.6%)
7	242 (0.6%)
8	106 (0.3%)
9	48 (0.1%)
10	24 (0.1%)
>=11	10 (0.02%)
Duration of the 1st deployment, days, median [25–75 percentile]	136 [101–182]
Total duration of all deployments, days, median [25–75 percentile]	201 [136–360]
Total duration of all deployments, n (%)	
30–190 days	18,946 (46.8%)
191 or more days	21,498 (53.2%)
Returned from 1st deployment after 1-1-2004, n (%)	18,495 (45.7%)
Started 1st deployment after 1-1-2004, n (%)	17,379 (43.0%)
Time between return from 1 st deployment (before or after 1-1-2004) and study exit, years, median [25–75 percentile]	9.2 [5.1–14.1]
Time between return from last deployment and study exit, years, median [25–75 percentile]	5.0 [2.8–8.8]

3.2 Incidence of mortality and suicide

During the follow-up period, 1,388 men from the general working population, 252 veterans and 199 non-veterans died (Table 3). Between 2004 and 2012 and after first deployment, 22 veterans died by suicide. Between 2004 and 2012, 156 men of the general working population and 27 nonveterans died by suicide. The follow-up time of the veterans was comparable with that of the general working population (i.e. the median person-years was 8.66 for the veterans and 8.99 for the general working population) but longer than that of the non-veterans (median person-years = 4.14). The incidence rates of suicide for these groups were 11.4 suicides per 100,000 person-years for the general working population, 8.0 for veterans and 11.2 for non-veterans.

Table 3. Mortality, suicide and follow-up time

	General working population n=165,154	Veterans n=40,444	Non-veterans n=33,364
Died (including suicide mortality), n (%)	1,388 (0.84%)	252 (0.62%)	199 (0.60%)
Suicide mortality, n (%)	156 (0.09%)	22 (0.05%)	27 (0.08%)
Follow-up time (person-years, median [25–75%])	8.99 [6.5–8.99]	8.66 [4.8–8.99]	4.14 [2.2–7.7]
Follow-up time (sum of person-years)	1,364,667	276,510	240,351
Incidence rate of suicide	11.4	8.0	11.2
Study entry = Date of entry into the study. Study exit = Date of exit from the study (i.e. date of censoring). Note: Mortality that took place between 1-1-2004 and 31-12-2012 was examined. Mortality that took place after 1-1-2004 during the first deployment (n=11) was excluded as military personnel were considered to be exposed after 30 days of deployment.			

3.3 Risk of mortality and suicide

Cox regression analyses

Compared with the general working population, the risk of dying from all causes during the follow-up period was significantly lower for veterans (i.e. after first deployment), after two or more deployments and after 30–190 days of deployment. After additionally adjusting for changes in receipt of social security benefits over time, this risk of dying during the follow-up period was no longer significantly different (Table 4). The risk of dying from all causes was not significantly different for veterans (i.e. after first deployment; after one or after two or more deployments; and after 30–190 days or 191 or more days of deployment) from the risk for non-veterans, before and after adjustments were made for rank and changes in receipt of social security benefits (Table 4).

The risk of dying by suicide during the follow-up period for veterans (i.e. after first deployment; after one or after two or more deployments; and after 30–190 days or 191 or more days of deployment) was not significantly different from the risk of dying by suicide for the general working population or non-veterans, before and after adjustments were made for rank (i.e. only when comparing with non-veterans) and changes in receipt of social security benefits (Table 5).

Whether suicide mortality rates differed depending on the missions on which veterans were deployed to could not be examined because of statistically very small numbers of suicides for each mission. Also, for privacy reasons Statistics Netherlands did not allow the reporting of the numbers of suicide per mission, because of a risk of information disclosure about individuals when numbers are below 10.

Sensitivity analyses

Four sensitivity analyses were performed (not presented). Excluding military personnel who were already deployed before 1-1-2004, excluding time during the first and subsequent deployments, stratifying for rank and adjusting for calendar year in the Cox regression analyses did not affect the results: the risk of dying from all causes and the risk of dying from suicide of veterans during the follow-up period were not statistically significantly different compared to the risk in the general working population and non-veterans.

Table 4. Relative Risk of mortality according to veteran status, total number of deployments and total duration of deployments

Veterans compared with the general working population	Model 1: adjusted for age, RR (CI) ¹	<i>Adjusting for rank is not possible</i>	Model 3: adjusted for age and social security, RR (CI) ³
Veterans vs. general working population	0.84 (0.74–0.96)*, 2	/	0.96 (0.84–1.10)
Total number of deployments			
1 deployment (vs. general working population)	0.87 (0.73–1.04)	/	0.98 (0.82–1.18)
≥ 2 deployments (vs. general working population)	0.82 (0.68–0.98)*, 2	/	0.93 (0.77–1.13)
Total duration of deployments			
30–190 days (vs. general working population)	0.82 (0.69–0.99)*, 2	/	0.93 (0.77–1.12)
191 days or more (vs. general working population)	0.86 (0.72–1.03)	/	0.99 (0.82–1.19)
Veterans compared with non-veterans	Model 1: adjusted for age, RR (CI) ⁴	Model 2: adjusted for age and rank, RR (CI) ⁴	Model 3: adjusted for age, rank and social security, RR (CI) ⁵
Veterans vs. non-veterans	0.89 (0.73–1.09)	0.93 (0.76 – 1.14)	0.96 (0.78–1.17)
Total number of deployments			
1 deployment (vs. non-veterans)	0.91 (0.73–1.15)	0.94 (0.75–1.19)	0.96 (0.76–1.21)
≥ 2 deployments (vs. non-veterans)	0.87 (0.68–1.11)	0.91 (0.71–1.17)	0.95 (0.74–1.21)
Total duration of deployments			
30–190 days (vs. non-veterans)	0.86 (0.69–1.09)	0.89 (0.71–1.13)	0.91 (0.72–1.15)

Veterans compared with non-veterans	Model 1: adjusted for age, RR (CI) ⁴	Model 2: adjusted for age and rank, RR (CI) ⁴	Model 3: adjusted for age, rank and social security, RR (CI) ⁵
191 days or more (vs. non-veterans)	0.93 (0.73–1.18)	0.97 (0.76–1.24)	1.01 (0.79–1.29)
<p>*statistically significantly different from 1.00, $p < 0.05$, RR=Relative Risk, CI=95% confidence interval. ¹Deaths of veterans and working population: 1,640, ²After additionally adjusting for receipt of social security benefits (model 3), the relative risk was no longer statistically significantly different from 1.00, ³Deaths of veterans and working population: 1,640, cases with missing values n=595, ⁴Deaths of veterans and non-veterans: 451, ⁵Deaths of veterans and non-veterans: 450, cases with missing values n=289.</p>			

Table 5. Relative Risk of *suicide* according to veteran status, total number of deployments and total duration of deployments

Veterans compared with the general working population	Model 1: adjusted for age, RR (CI) ¹	<i>Adjusting for rank is not possible</i>	Model 3: adjusted for age and social security, RR (CI) ²
Veterans vs. general working population	0.68 (0.43–1.06)	/	0.77 (0.49–1.21)
Total number of deployments			
1 deployment (vs. general working population)	0.77 (0.43–1.39)	/	0.87 (0.48–1.56)
≥ 2 deployments (vs. general working population)	0.59 (0.31–1.12)	/	0.68 (0.35–1.29)
Total duration of deployments			
30-190 days (vs. general working population)	0.68 (0.37–1.25)	/	0.76 (0.41–1.40)
191 days or more (vs. general working population)	0.67 (0.37–1.25)	/	0.78 (0.42–1.44)
Veterans compared with non-veterans	Model 1: adjusted for age, RR (CI) ³	Model 2: adjusted for age and rank, RR (CI) ³	Model 3: adjusted for age, rank and social security, RR (CI) ⁴
Veterans vs. non-veterans	0.58 (0.31–1.06)	0.67 (0.36–1.26)	0.70 (0.37–1.31)
Total number of deployments			
1 deployment (vs. non-veterans)	0.67 (0.33–1.36)	0.75 (0.37–1.53)	0.77 (0.38–1.58)
≥ 2 deployments (vs. non-veterans)	0.49 (0.22–1.06)	0.59 (0.26–1.31)	0.62 (0.28–1.38)
Total duration of deployments			
30–190 days (vs. non-veterans)	0.58 (0.28–1.20)	0.66 (0.31–1.37)	0.68 (0.32–1.42)

Veterans compared with non-veterans	Model 1: adjusted for age, RR (CI) ³	Model 2: adjusted for age and rank, RR (CI) ³	Model 3: adjusted for age, rank and social security, RR (CI) ⁴
191 days or more (vs. non-veterans)	0.57 (0.27–1.22)	0.69 (0.32–1.51)	0.73 (0.33–1.59)
RR=Relative Risk, CI=95% confidence interval. ¹ Suicide deaths of veterans and working population: 178, ² Suicide deaths of veterans and working population: 178, cases with missing values n=595, ³ Suicide deaths of veterans and non-veterans: 49, ⁴ Suicide deaths of veterans and non-veterans: 49, cases with missing values n=289.			

4 Discussion

Main findings

The objectives of this epidemiological study were to (1) describe total mortality rate and suicide mortality rate among veterans based on mortality registry data from Statistics Netherlands; (2) examine how these rates compare with the total mortality and suicide rates among the general working population and among non-veterans; (3) examine whether suicide mortality rates differ depending on the mission on which military personnel had been deployed.

During the follow-up time of nine years in the period 2004–2012 and after first deployment, 22 of the 40,444 male veterans (8.0 per 100,000 person-years) died by suicide. Of the 165,154 males from the general working population (i.e. an age-matched sample of the Dutch male working population), 156 died by suicide (11.4 per 100,000 person-years) and 27 of the 33,364 male non-veterans (11.2 per 100,000 person-years) died by suicide. For mortality from all causes, the numbers of deaths were 252, 1,388 and 199 for veterans, the general working population and non-veterans, respectively.

Cox regression analyses that took into account age, last rank and changes during the follow-up period in receipt of social security benefits showed that total and suicide mortality in the veterans group were not significantly different from total and suicide mortality in the general working population and non-veterans groups. Nor did the number and duration of deployments have an effect on either total or suicide mortality when veterans were compared with the general working population or with non-veterans.

The question whether suicide mortality differed between missions could not be answered because the relatively rare occurrences of suicide precluded a valid statistical comparison between missions.

Comparison groups

In this study, male veterans were compared with two groups: the general working population and male non-veterans. The general working population was chosen as a comparison group because employed people are more likely to have good health, as good health is necessary for work (Li and Sung, 1999). This selection of relatively healthy people in the working population is referred to as the healthy worker effect. The healthy worker effect may explain the finding that observed numbers of suicide deaths in veterans were significantly lower than expected based on suicide mortality rates in the Dutch general population (the SMR calculation, see Appendix 2), but did not differ from those of a sample of the general working population (the Cox regression analysis).

Compared with the general working population, military personnel (veterans as well as non-veterans) are likely to be in even better health because they must meet additional physical and mental health requirements, both at entry into military service and during service. This is referred to as the healthy soldier effect (e.g. Kang and Bullman, 1996) and may bias the comparison with the general working population. This difference in health status does not exist between veterans and non-veterans. Still, some military personnel might never be deployed because their physical and mental health does not meet the

requirements for deployment. This selection effect of fit soldiers for deployment is called the healthy warrior effect (Haley, 1998). It is not known whether the healthy warrior effect influenced the results of the present study, because no information was available on why non-veteran personnel were not deployed. However, because military personnel who are not suitable for deployment because of their health will eventually have to leave the military, a healthy warrior effect is expected to have influenced the results only minimally. It is likely that most non-deployed personnel have not yet been deployed simply because there has not been a deployment opportunity for them.

Comparison with previous studies

As described in the Introduction, previous studies on suicide risk among deployed military personnel found inconsistent results. Some reported a higher risk (e.g. Kaplan et al., 2007), some a lower risk (e.g. Kang et al., 2015) and others, in line with our results, no significant difference (LeardMann et al., 2013; Reger et al., 2015). However, those studies were performed among military personnel from countries other than the Netherlands. Military personnel may differ between countries, which will make comparisons between countries problematic (see, e.g., Michel et al., 2007). For instance, military personnel may be deployed on different types of mission and, during those missions, perform different types of task. They may also have been recruited in accordance with different criteria, and differ with respect to training, deployment durations, medical care (during and possibly after military service) and socioeconomic circumstances. Differences in study results may also be the result of differences in study design, analytical methods, and definitions of veteran groups and comparison groups. Thus, comparisons between the findings of the present study and those of previous studies should be made with caution; a systematic review approach should be used, which is beyond the scope of this study. The study that is most closely comparable with the present study is a study among Dutch Balkans veterans (Schram-Bijkerk and Bogers, 2011). No statistically significant differences in suicide risk were found between Balkans-deployed personnel, personnel not deployed to the Balkans and the general Dutch age-matched male population. However, the results of that study cannot be compared directly with the findings of the present study because the study of Balkans veterans used a different follow-up period and included data on conscripted military personnel as well as professional military personnel.

The present study found an incidence rate of suicide among Dutch veterans of 8.0 per 100,000 person-years. Statistics Netherlands has reported that standardised suicide numbers per 100,000 Dutch males between 2004 and 2012 fluctuated between 11.7 and 14.3 per year (CBS, 2014). These rates, however, apply to males of all ages, including individuals aged 0–17 years and both working and non-working men. Published suicide rates from the Netherlands that can be compared directly with our rates are not available.

Scope of the study

The scope of the study and its conclusions are limited to post-deployment (total and suicide) mortality during the period 2004–2012 in the group of veterans in service on or after 1-1-2004. The findings can

therefore not be generalised to other periods, all missions and other definitions of veterans. This is discussed below in more detail. Data on military personnel from 1-1-2004 onwards is reliable, complete and readily available and was therefore used in this study. The veterans and non-veterans thus included personnel who entered the military before 2004 and were still in service at 1-1-2004 and personnel who entered the military on or after 1-1-2004. If data on veterans and non-veterans who were in service before 1-1-2004 can be validated in the future and thereby becomes available, the follow-up period will increase, the statistical power of the study may increase and the scope of the study may extend to veterans who were deployed on missions that took place before 1-1-2004. A large part of the military personnel who were deployed on certain missions before 1-1-2004 were not included in the current study because they were no longer in service on 1-1-2004. Whether extending the study's follow-up time over a longer period (i.e. <1-1-2004), which would include more missions, would affect the results of the study is unknown.

Veterans were defined in this study as those who had been deployed for at least 30 consecutive days. This ensured that personnel who had been deployed for only short periods, and probably those who had been deployed for working visits, were excluded from the group of veterans. If data becomes available on type of deployment, i.e. working visits by specialists, suppliers or other personnel, part of the personnel deployed for less than 30 days may also be included in the veterans group. It is unknown whether excluding men who had been deployed for less than 30 days from the group of veterans and treating them as non-veterans affected the results.

In the statistical analyses, only post-deployment mortality was studied. Thus, (suicide) mortality was counted among the veterans group only if an individual had died after returning from his first deployment of at least 30 consecutive days, and mortality during the first deployment was excluded from the analyses. Note that mortality during subsequent deployments was included; excluding these deaths in a sensitivity analysis did not change the result. It was not examined whether including mortality during first deployment would affect the results. Finally, this study was limited to suicide mortality, i.e. only actual suicides were studied. However, in the context of the discussion about a possible relationship between deployment and psychological problems, nonfatal suicide attempts may also be relevant outcomes. In the general population, the number of suicide attempts highly exceeds the number of actual suicides (Hoeymans and Schoemaker, 2010).

Methodological issues

A number of methodological issues are discussed below that may have influenced the results of the study.

First, the registration of mortality by Statistics Netherlands is the only systematic and central registration of mortality in the Netherlands. Therefore, the most reliable source of information on suicide mortality was used. Checks on its reliability showed high reliability for suicide, amongst other mortality causes (Harteloh et al., 2010). However, deaths as a result of suicide may not always be recognised as such. It is therefore not always registered as such by Statistics Netherlands. Some deaths registered as 'events of undetermined intent' (ICD codes Y10–Y34), e.g. a one-sided car accident, may actually be cases of suicide.

Such cases may have occurred in veterans, non-veterans and the general working population, so more individuals may have committed suicide in all three groups but their deaths are not classified as such. In addition, the causes of deaths that occur abroad and therefore during deployments are not systematically registered by Statistics Netherlands, although information may reach Statistics Netherlands as to how military personnel have died (e.g. from acts of war). The possibility that some suicide deaths have been missed in the present study may be explored in future studies by using information on mortality during specific deployments of military personnel from the Ministry of Defence or the Netherlands Institute for Military History (in Dutch: Nederlands Instituut voor Militaire Historie; NIMH).

Second, over half of veterans returned from their first mission before 1-1-2004 (the start of the study). This may explain the median duration of approximately nine years between end of last deployment and study exit. The individuals who died by suicide before 1-1-2004 are not included in this study. Therefore, the included veterans already deployed before 1-1-2004 (as well as the included non-veterans already in service before 1-1-2004) may to a certain extent be a selection of 'survivors'.

To check whether this selection effect influenced the results, veterans deployed before 1-1-2004 were excluded from the Cox regression analyses in a sensitivity analysis. This did not affect the results, although this analysis should be interpreted with caution; fewer veteran males and therefore even fewer suicide deaths were examined due to the exclusion, potentially resulting in insufficient statistical power.

Third, the statistical analyses were adjusted for some factors affecting the risk of suicide (age, changes over time in receipt of social security benefits and last rank) but not all such factors. In the present study the Cox regression analyses were adjusted for last rank as a proxy for socioeconomic status, but this could be done only for military personnel and not for the general working population. Information on partner status and level of education is available from Statistics Netherlands, but because of time constraints it was chosen not to extend the analyses with additional adjustments for partner status and level of education. Future studies may explore whether adjusting for partner status and level of education affects the results.

Last, regarding the general working population, it is theoretically possible that some veterans deployed before 1-1-2004 who left the military before 1-1-2004 were included in this comparison group, although the number is expected to be small. It is unknown whether or how this affected the results.

Recommendations

This is the first study specifically on suicide mortality among Dutch deployed military personnel. This epidemiological study was designed to examine the incidence of suicide among veterans as a group. Among veterans, 22 suicides were observed. Among non-veterans, 27 suicides. To understand why these men committed suicide and whether and how their suicide was influenced by previous deployment, a different type of study could be conducted. Interviews with relatives, colleagues, employers and caregivers as well as an examination of personnel and medical files (i.e. a qualitative research method: psychological autopsy; de Groot et al., 2012; Burger et al., 2014) may be a suitable way to study individual cases of suicide. Importantly, this would enable

researchers to also examine suicides among female military personnel. Although qualitative research will not enable conclusions to be drawn about causality due to the relatively low numbers of suicides, it may provide more insight into the predictors of suicide among military personnel.

As mentioned above, this study only examined actual suicide. To gain greater insight into the possible consequences of deployment for veterans and how it affects their life, future studies may further expand the current research by also examining attempted suicides among military personnel.

Conclusion

This epidemiological study does not, for the Dutch situation, confirm reports from the US of higher suicide rates among deployed military personnel. There were no indications that suicide mortality rates among veterans deployed for more than 30 consecutive days exceeds the suicide mortality rates among the general working population and non-veterans. Whether this is also the case for specific missions could not be examined with the data available for the current study. It cannot be ruled out that different results might be found if a different follow-up period, including other missions, were studied.

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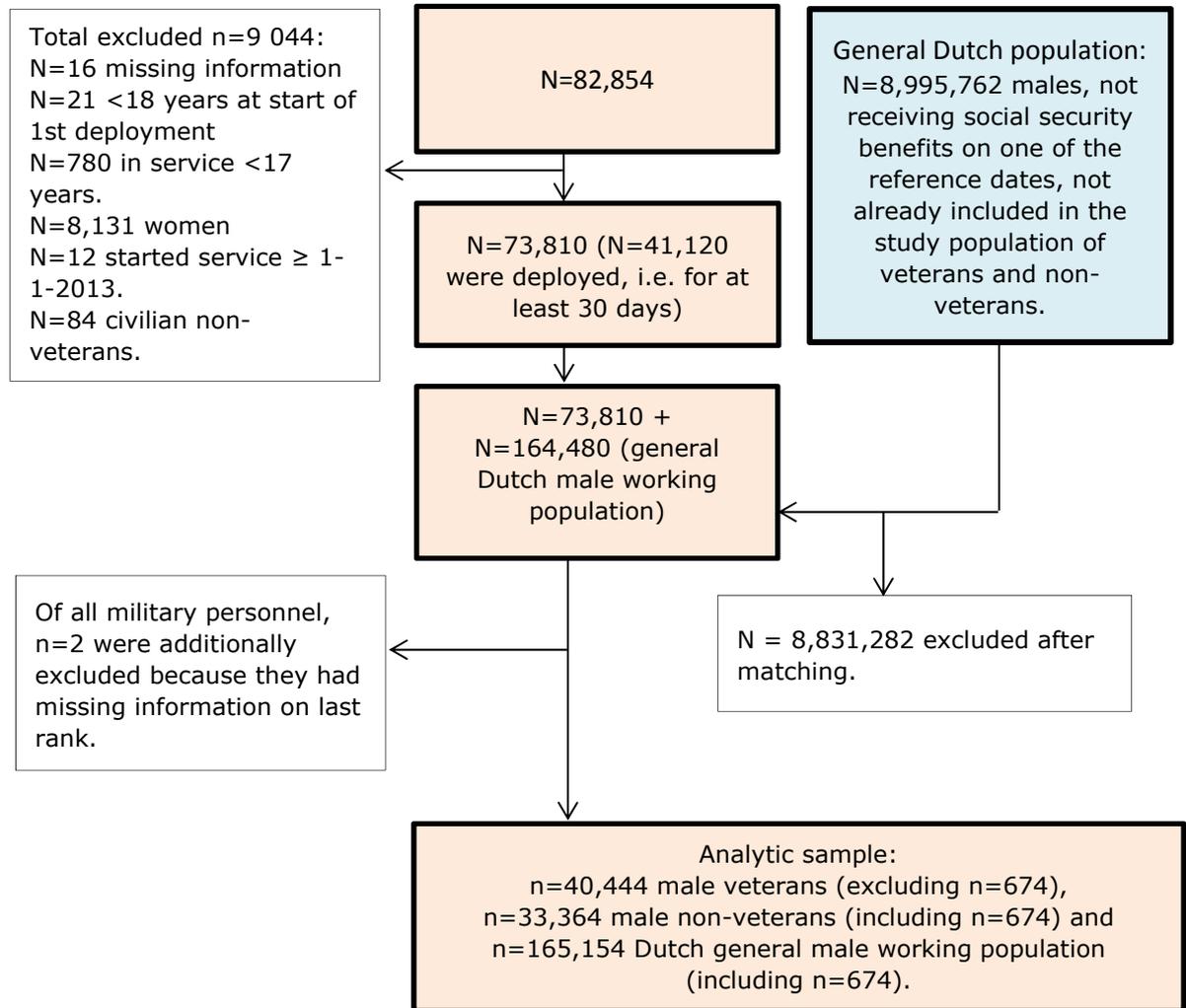
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Appendix 1

Selection of the analytic study population

Data was available on 82,854 military personnel. Female military personnel (n=8,131) were excluded because of the low number of suicides among women, resulting in insufficient statistical power for a valid analysis in women. A further 913 personnel were excluded from the data set because they had missing information on one of the examined variables, were deployed before the age of 18 years or hired before the age of 17, were hired on or after 1-1-2013 or were civilians who were never deployed (see Flow chart A1.1). This resulted in 73,810 military personnel. A random sample of the general Dutch male working population was then matched to the veterans (n=164,480). The same median age was observed for the Dutch general male working population (27.0 [21-39]) and veterans (27.0 [21-39]) because a random sample of the Dutch general male working population was matched by age to veterans. Nonveterans were younger (20.0 [18-26]). By design, none of the selected males of the Dutch general male working population were receiving social security benefits when they entered the study. Of all military personnel, 0.4% of veterans and 1.1% of non-veterans were receiving social security benefits on study entry. (The reason they were receiving such benefits while serving in the military is unknown but it may be due to an administrative error. In any case, 77.2% of those veterans and 83.9% of those non-veterans no longer received social security benefits within two weeks of their entry into the study.) The exclusion of these individuals did not alter the results of the Cox regression analyses (results not presented). An additional two individuals were excluded because they had missing data on last rank. Of all veterans (n=41,118), n=674 did not return from their first deployment before censoring (i.e. before the end of the study). Therefore, they are not considered veterans in the current study but were used as controls (i.e. depending on the analysis, as the general working population or non-veterans). In total, therefore, an analytic sample was examined of n=40,444 veterans, n=33,364 non-veterans and n=165,154 men from the general working population.



Flow-chart A1.1: Selected male veterans, Dutch general male working population and male non-veterans.

Appendix 2

Standardized Mortality Ratio's (SMRs)

Table A2.1 shows observed numbers of deaths for veterans and non-veterans and expected numbers based on incidence rates in the general population (i.e. all males from the Dutch general population of comparable age). The observed number of deaths (n=252) for veterans (i.e. after return of first deployment) was not significantly different from the expected number of deaths. The observed number of deaths for veterans according to the total number of deployments and total duration of deployments were also not significantly different from the expected number of deaths. The risk of death in non-veterans was also not significantly different from the expected number of deaths (Table A2.1). The observed number of suicides (n=22) in veterans was 42% lower than the expected number (SMR=0.58 (95% CI 0.36–0.88)). The risk of suicides (n=10) was 50% lower for veterans after two or more deployments than the expected number (SMR=0.50 (95% CI 0.24–0.93)). The risk of suicide in veterans who were deployed for 190 days or less and veterans who were deployed for more than 190 days was not significantly different from the expected number of suicides. The risk of suicide in non-veterans was not significantly different from the expected number of deaths (Table A2.2).

Note that standardisation to the general population, as done for SMR calculation, provides information on differences in incidence between veterans and the general population. The standardisation to the general population was performed for veterans and non-veterans separately. The SMRs of veterans and non-veterans cannot be compared, because this 'indirect' comparison is biased by differences in the distributions of age and other characteristics between these groups. In the Cox regression analyses, adjustments can be made for covariates (i.e. age, rank, receipt of social security benefits), providing the best available information on differences across veterans and non-veterans.

Table A2.1. Standardized Mortality Ratios of all causes of mortality among veterans (according to veteran status, total number of deployments and total duration of deployments) and non-veterans

All Causes of mortality ¹	Obs ²	Exp ³	SMR ⁴ (CI)
Veterans	252	267	0.94 (0.83 – 1.07)
Total number of deployments			
1 deployment	131	134	0.98 (0.82 – 1.16)
≥ 2 deployments	121	133	0.91 (0.76 – 1.09)
Total duration of deployments			
30–190 days	121	134	0.90 (0.75 – 1.08)
> 190 days deployed	131	133	0.98 (0.82 – 1.17)
Non-veterans	199	174	1.15 (0.99 – 1.32)
**p<0.05, CI= 95% confidence interval, ¹ ICD-10 (International classification of diseases, 10 th revision): C00-D48: A00-Y89. ² observed number of cases, ³ expected number of cases (rounded), ⁴ Standardized mortality ratio			

Table A2.2. Standardized Mortality Ratios of suicide among veterans (according to veteran status, total number of deployments and total duration of deployments) and non-veterans

Suicide ¹	Obs ²	Exp ³	SMR ⁴ (CI)
Veterans	22	38	0.58 (0.36–0.88)**
Total number of deployments			
1 deployment	12	18	0.67 (0.35–1.17)
≥ 2 deployments	10	20	0.50 (0.24–0.93)**
Total duration of deployments			
30–190 days	11	19	0.59 (0.30–1.06)
> 190 days deployed	11	19	0.57 (0.28–1.01)
Non-veterans	27	24	1.14 (0.75–1.66)
**p<0.05, CI= 95% confidence interval, ¹ ICD-10 (International classification of diseases, 10 th revision): X60–84, ² observed number of cases, ³ expected number of cases (rounded), ⁴ Standardized mortality ratio			

Appendix 3

Determination of exposure status and person-years

Exposure was examined in three ways: after first deployment, total number of deployments and total duration of deployment. If first deployment took place before 1-1-2004 and the individual was still in the military at 1-1-2004, exposed time always began at 1-1-2004 (Figure A3.1). All three exposure variables were examined as time-dependent variables in the Cox regression analyses.

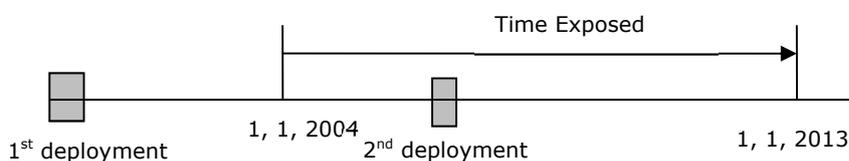


Figure A3.1. Fictional example of exposed time when first deployment took place before 1-1-2004 and the deployed individual was still in service on 1-1-2004.

Exposure after first deployment (i.e. of at least 30 days) was included as exposure variable, depending on the date of return from the first deployment. Time after end date of first deployment was counted as time spent in the exposed group, regardless of subsequent deployments (Figure A3.1 and A3.2). Person-time between entrance in the cohort and start of first deployment was not considered as time spent in the exposed group, and corresponding person-years were added to the non-exposed group. Time during first deployment was excluded from SMR calculations because the study focused on post-deployment mortality. For the same reason, in the Cox regression models, time during the first deployment was categorised as a separate category of the time-dependent variable 'first deployment' to ensure it was excluded from the exposed time of veterans and non-veterans or men from the general working population (i.e. the variable 'first deployment' was coded as 0= the general working population or non-veterans; 1=veterans; 99=time during first deployment). Therefore, mortality numbers (by suicide or other causes) reported in the tables showing the results of the SMRs and Cox regression analyses do not include mortality during the first deployment.

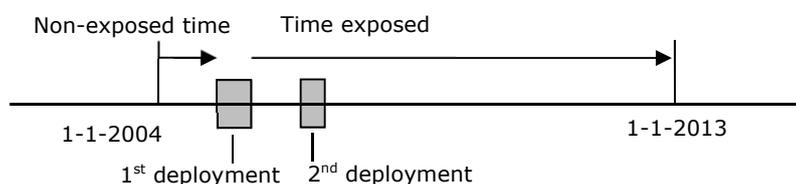


Figure A3.2. Fictional example of exposed time when first deployment took place after 1-1-2004 and deployment status was examined.

Second, the total number of deployments were examined as exposure variable (Figure A3.3). Time after end date of first deployment was counted as time spent in the exposed group, regardless of subsequent deployments. Person-time between entrance in the cohort and start of first deployment was again added to the non-exposed group. Also, time during first deployment was excluded from SMR calculations. In the Cox regression models, time during first deployment was categorised into a separate category (i.e. 0= non-veterans or the general working population; 1= one deployment; 2= two deployments or more; 99= time during first deployment). Time during subsequent deployments was not excluded because deaths during subsequent deployments are potentially the result of previous experienced deployments.

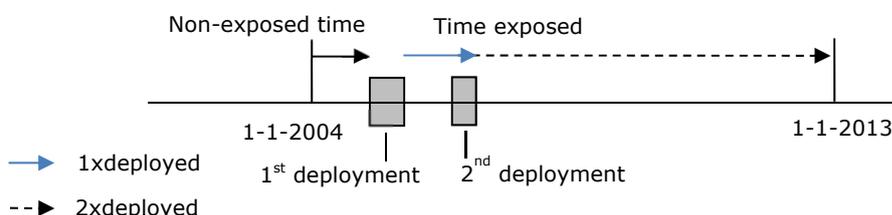


Figure A3.3. Fictional example of exposed time when first deployment took place after 1-1-2004 and when total number of deployments was examined.

Third, the total duration of deployments in days was examined. Time after end date of first deployment was counted as time spent in the exposed group, regardless of subsequent deployments. Again, person-time between entrance in the cohort and start of first deployment was added to the control group, time during first deployment was excluded from SMR calculations and in the Cox regression models categorised into a separate category (i.e. 0=non-veterans or general working population; 1=30-190 days; 2=191 or more; 99=time during first deployment). Time during subsequent deployments was not excluded from the exposed time (Figure A3.4 and A3.5).

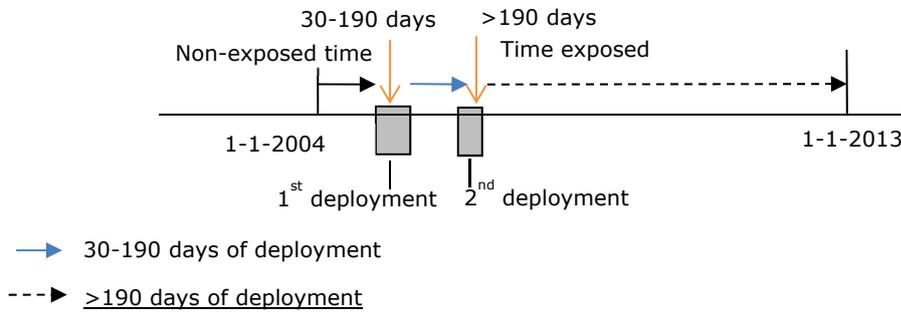


Figure A3.4. Fictional example of exposed time when first deployment took place after 1-1-2004, total duration of deployments was examined and the total duration of the first and second deployment was >190 days.

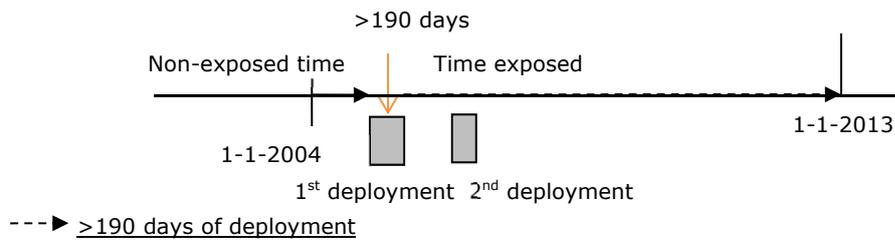


Figure A3.5. Fictional example of exposed time when first deployment took place after 1-1-2004, total duration of deployments was examined and the duration of the first deployment was >190 days.

Appendix 4

Members of the Scientific Advisory Board

Provided independent advice regarding the scientific quality of this study.

Name	Affiliation
Dr C.J. IJzermans (chair)	Netherlands Institute for health services research (In Dutch: Nederlands Instituut voor onderzoek van de gezondheidszorg; NIVEL)
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Members of the Societal Advisory Committee

Provided advice regarding this study from a broad, societal context, applicable to the practice and policy of the Ministry of Defence.

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Kelly Rijs | Rik Bogers

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