

## PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (<http://bmjopen.bmj.com/site/about/resources/checklist.pdf>) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below.

### ARTICLE DETAILS

<b>TITLE (PROVISIONAL)</b>	Suicide & All-Cause Mortality in Swedish Deployed Military Veterans: A Population-Based Matched Cohort Study
<b>AUTHORS</b>	Pethrus, Carl-Martin; Johansson, Kari; Neovius, Kristian; Reutfors, Johan; Sundström, Johan; Neovius, Martin

### VERSION 1 - REVIEW

<b>REVIEWER</b>	Jim Thompson Veterans Affairs Canada
<b>REVIEW RETURNED</b>	09-Oct-2016

<b>GENERAL COMMENTS</b>	<p>Congratulations on tackling this complex and important project. The conscript dataset is a unique opportunity. Using data linkage between a conscript database and national mortality and health services databases, your study assessed suicide risk in previously deployed Swedish military personnel compared to matched comparators. The topic is very important. Much remains to be learned about suicide and suicide correlates in military populations from comparative population data, and as you point out there is conflicting evidence.</p> <p>I had difficulty following the paper because I was unable to get both a clear picture of the veteran and comparator groups and a clear sense of the timeline for the predictor variables.</p> <p>Abstract</p> <p>Explicitly define "veteran". As you know, the term has many meanings internationally. I was unable to determine how you used the term both in the abstract and in the main paper. Similarly, the comparator populations are unclear.</p> <p>Owing to difficulty in understanding the groups, it was hard to follow the results section of the abstract.</p> <p>Introduction</p> <p>P. 4 The first paragraph is disorienting. The introduction begins by giving details on UK military engagements but the study is about suicides in Swedish veterans.</p> <p>You could cite this Canadian study as another example:  <a href="http://www.forces.gc.ca/en/about-reports-pubs-health/report-on-suicide-mortality-caf-2015.page">http://www.forces.gc.ca/en/about-reports-pubs-health/report-on-suicide-mortality-caf-2015.page</a>  They found a 1.46 times higher SMR for suicide over the 35-year period in male Canadian military veterans (released Canadian Forces members with any length of service) compared to similarly</p>
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	<p>aged males in the Canadian general population.</p> <p>The following review of Canadian veteran population studies might be of interest:  <a href="http://jmvfh.utpjournals.press/doi/abs/10.3138/jmvfh.3258">http://jmvfh.utpjournals.press/doi/abs/10.3138/jmvfh.3258</a></p> <p>Note that that there is emerging evidence from the US longitudinal studies of the presence of pre-service mental health problems in recruit which are thought to predispose some individuals to mental health problems during exposure to service stressors (e.g. one of the Army STARRS studies). In the UK, the Kings College group in London published a similar finding in that mental health problems in ex-service members were more likely in those with mental health problems in service.</p> <p>Also evidence of higher prevalence of adverse childhood experiences in US military:  <a href="http://jamanetwork.com/journals/jamapsychiatry/article-abstract/1890091">http://jamanetwork.com/journals/jamapsychiatry/article-abstract/1890091</a> and a significant literature from the US and Canada now on ACE correlations with serving members' mental health.</p> <p>P. 4 Last paragraph. Provide more clarity in the nature of the veteran group and the two comparator groups in the objectives. Explicitly define "veteran". As you know, the term has many meanings internationally. This would orient the reader from the start.</p> <p>Methods</p> <p>P. 5 Where is eFigure 1?</p> <p>P. 6 Clarify the nature of the "veteran" and two comparator populations. The process should be transparent to readers. Consider definitions in terms of veteran, non-veteran, deployed, still-serving, released (or ex-service), and civilian (or never served), plus any other distinguishing features that a reader would need to understand. A table would help.</p> <p>I think that you sub-divided the conscript dataset into:</p> <ul style="list-style-type: none"> <li>- Those who had been conscripted and deployed.</li> <li>- Those who had not deployed?</li> </ul> <p>And then matched the non-deployers to the deployers by variables available in the conscript database, in two ways:</p> <ul style="list-style-type: none"> <li>- Matched by age and sex alone</li> <li>- Matched by age, sex and the other variables available in the conscript database?</li> </ul> <p>And then linked in cause of death data for those who could be included in the study.</p> <p>And then it was not clear how patient registry data were used. If I am wrong about this, then that might help you to revise the explanation in the Methods section.</p> <p>P.7. What was the source of data for the variables, and at what time point were the data collected? At conscription assessment? Later in life? The Methods section needs more clarity on how the analyses were done with respect to time frames.</p> <p>P. 7. Briefly explain the Stanine Scale and provide a reference.</p> <p>P. 7 The ability to detect pre-recruitment mental health issues using</p>
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	<p>the national patient registry is a significant strength, presuming that it provides a complete mental health history.</p> <p>P.7 BMI based on height and weight is not an optimal measure of physical health owing to problems such as muscle mass in military personnel. Exercise capacity at recruitment is not necessarily an indicator of physical health status later in life. Is there any source of data on presence or absence of physical and mental health conditions? Consider mentioning limitations in information on physical health status in the Limitations section of the Discussion.</p> <p>P. 8 Expand on the manner in which matched comparisons were done using ANOVA and logistic regression. The phrase “conditioning on the matching set with each set consisting of one military veteran and up to 5 matched comparators” is unclear.</p> <p>Results</p> <p>Owing to the lack of clarity in how the veteran and comparison groups were defined and absence of figure numbers on the figures, I had difficulty understanding the results section.</p> <p>The text in the Results section is too sparse I think. More explanatory information would assist readers not familiar with the procedures you used. For example, in the figure with the four event graphs, you could explain in the text “Figure _ shows ...”. What is a “person-year” in this context?</p> <p>There are more figures than captions and figures are not labelled, so references to figures in the text do not match the figures provided for review, making it hard to follow the Results section.</p> <p>Discussion</p> <p>P. 10 First paragraph: Military veterans showed no difference compared to who and had lower risk of mortality than who?</p> <p>P. 10 First paragraph: It is unclear why the findings in the first two sentences lead to the conclusion that there is difficulty in selecting relevant comparators.</p> <p>The balance of the discussion is incomplete. More military suicide literature could be cited.</p> <p>P. 10 In making comparisons to other studies, consider differences in methodologies, populations studied and culture.</p> <p>P. 10 “The Swedish study showed a 50% lower suicide risk among veterans ...” than who?</p> <p>P. 10 I think that that the MilCoh study found no difference with respect to deployment, but if I recall that was after adjustment. There can be more physical and mental health problems in those deployed to high risk locations than the non-deployed, but health problems and suicide also occur in non-deployed military personnel.</p> <p>P. 10 The mechanism section is incomplete. Perhaps start by reminding the reader of the main suicide finding for which you explore mechanisms. Then discuss the findings and add context from the literature. As I understand it, and I could be wrong, your</p>
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	<p>data sources could not provide information on a variety of current factors that play roles in suicide beyond the presence of mental health problems such as proximal life stressors owing to social factors, economic factors, and physical health; health services access/effectiveness; help-seeking; personal predisposing factors and access to lethal means.</p> <p>P 10 What are implications for services and policy?</p> <p>P. 11 The last sentence of the implications section should be moved up higher to the first paragraph in Previous Research, and expanded for clarity. What did the initial Swedish studies find?</p> <p>Conclusions</p> <p>Clarify timeline in the first sentence: when with respect to suicide were those factors measured? Were they all distal at conscription or were some proximal to suicide?</p>
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<b>REVIEWER</b>	Joseph Logan Centers for Disease Control and Prevention, USA
<b>REVIEW RETURNED</b>	17-Nov-2016

<b>GENERAL COMMENTS</b>	<p>This article “Suicide, All-Cause Mortality and The Healthy Soldier Effect: A Population-Based Matched Cohort Study” summarizes a study that compared a large cohort of military Veterans to two matched cohorts of comparators with respect to suicide mortality and all-cause mortality. Overall, the paper is well written. There are some critical pieces of information that need be clarified. Some minor editing is also needed. Comments are bulleted by section below.</p> <p>Abstract</p> <ul style="list-style-type: none"> <li>• Objective – please clarify if the comparators are either matched civilian cohorts or matched veteran cohorts who did not volunteer to deploy abroad. Also, it is important for the reader to understand which groups are considered to be soldiers in this analysis. Please clarify.</li> <li>• In the participants and results sections, please clarify the primary veteran group of interest inclusion definition (e.g., “only veterans who have served abroad.”). As previously stated, I was unable to determine if the authors compared veterans who served abroad versus other veterans who stayed inland or veterans who served abroad versus civilians/general population. Also, please provide details on the Ns for each group. The final sample sizes for the groups are unclear.</li> </ul> <p>Introduction</p> <ul style="list-style-type: none"> <li>• The introduction was succinct and nicely stated. My only comment is that the introduction lacked updated references on suicide risk between US military/veteran populations and US civilians for the Iraq/Afghanistan war period. True, the risk of suicide was lower among service members versus civilians in the Gulf War era. However, risk of suicide among US active duty service members surpassed US civilians in 2008. Suicide risk among active duty members has recently dropped below age/sex comparable civilians; however, the suicide rate among young recently discharged veterans (aged 18-24) has sharply increased and is now ten-fold</li> </ul>
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	<p>higher than age comparable civilians. I recommend incorporating the recent VHA report on suicide 2001-2014 (Suicide Among Veterans and Other Americans 2001–2014).</p> <ul style="list-style-type: none"> <li>• Also, I made a suggestion in the Discussion section below that is relevant to the introduction. Some clarity in the introduction can improve the understanding of the discussion. Please read comments.</li> </ul> <p>Methods</p> <ul style="list-style-type: none"> <li>• As stated in the abstract, it appears that the entire sample includes veterans according to the opening paragraph and the 'exposure' of interest is 'voluntary deployment abroad.' If so, then the authors will not be able to determine the 'healthy soldier effect' if the entire population includes veterans and considered to be soldiers. The authors will only be able to examine volunteerism for deployments abroad as the main independent variable and therefore will have to control for a potential selection bias; those who volunteer for deployments abroad might simply be healthier (physically and mentally) than veterans who do not volunteer for deployments abroad. The first comparison with the comparators matched by age, sex, cognitive ability, psychological assessment, mental health problems, BMI, and deployment year is the most pure analysis of comparing volunteerism for deployments abroad versus not volunteering controlling for such selection bias; however, there could still be some unknown variables linking the volunteerism for deployments and the outcomes. The authors might consider including a propensity score for volunteerism to improve the analysis. All in all, this first comparison is still the most rigorous evaluation of volunteerism for deployment abroad and if this exposure variable is be interpreted as a proxy for "soldier," then it appears the authors fail to show a healthy soldier effect. If both groups are soldiers, then the analysis fails to show an association between volunteerism for deployment and the outcomes. The point of the second comparison is less clear if this group also consists entirely of veterans/soldiers. If this group is a veteran group, then the authors fail to prove the healthy soldier effect, considering everyone are veteran soldiers, and only provide evidence that those who volunteer for deployments abroad tend to be mentally and physically healthier than other veterans and therefore are less likely to experience suicidal outcomes.</li> <li>• One picky comment is that the field of suicidology does not call a suicide death a "completed suicide" anymore. This is viewed as a pejorative way of presenting these deaths. Please change "completed suicides" to "deaths by suicide." Otherwise, the authors will run the risk of losing the readership.</li> </ul> <p>Results</p> <ul style="list-style-type: none"> <li>• Please add sample sizes for all groups into the abstract</li> <li>• Please relabel "completed suicides" to "deaths by suicide"</li> </ul> <p>Discussion</p> <ul style="list-style-type: none"> <li>• If the last comparator is truly a general population and are not considered soldiers, but the first comparator group is considered to have included soldiers who did not voluntarily deploy, then the authors provide evidence for the healthy soldier effect but do not make a strong case for why they separated soldiers who volunteered for deployment abroad versus those who did not. If the first comparator group is considered to be the general population, and not soldiers, then the adjusted analysis (with all the matched</li> </ul>
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	variables) fails to prove the healthy soldier effect. If all groups are in essence considered to be soldiers, then the authors provide evidence that those who select for deployment abroad are healthier, but fail to provide evidence for the healthy soldier effect because everyone in this comparison is a soldier. Because these groups are still unclear with regard to who is considered a soldier, who is not, the reader cannot yet fully interpret the results and the rationale for the different comparisons. Therefore, I recommend doing a major revision to help improve the clarity of each study group and the rationale for each comparison. I also strongly encourage the authors to include text that clarifies the rationale for each comparison and the significance of each comparison in the introduction.
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## VERSION 1 – AUTHOR RESPONSE

Reviewer: 1 Reviewer Name: Jim Thompson Institution and Country: Veterans Affairs Canada  
Competing Interests: None declared

Congratulations on tackling this complex and important project. The conscript dataset is a unique opportunity. Using data linkage between a conscript database and national mortality and health services databases, your study assessed suicide risk in previously deployed Swedish military personnel compared to matched comparators. The topic is very important. Much remains to be learned about suicide and suicide correlates in military populations from comparative population data, and as you point out there is conflicting evidence. I had difficulty following the paper because I was unable to get both a clear picture of the veteran and comparator groups and a clear sense of the timeline for the predictor variables.

Response: We understand that it was difficult to follow who was a soldier and who was not. Reviewer 2 had the same impression. We sincerely apologize for not making this more clear in the initial version. In the revised version, the different groups are described in greater detail as outlined under R2.1, as well as in the new eTable 1. We hope that these changes make it more clear to the readers.

Abstract

R1.1

Explicitly define “veteran”. As you know, the term has many meanings internationally. I was unable to determine how you used the term both in the abstract and in the main paper. Similarly, the comparator populations are unclear. Owing to difficulty in understanding the groups, it was hard to follow the results section of the abstract.

Response: [Please also refer to the response under R2.1 above]

In the revised version, we have changed the term for the veterans to “deployed military veterans” and for comparators to “non-deployed comparators”. The groups are defined, matching factors listed, and purpose of each comparator group outlined in the new eTable 1 (see below). We hope that these revisions improve the clarity of our paper.



**eTable 1**

Identification	Group	Definition	Matching factors	Purpose
Military Service Conscription Register & SWIP	Deployed Military Veterans	Deployed abroad at some time-point between 1990 and 2013	NA	To determine the rate of death by suicide and all-cause mortality among Swedish deployed military veterans
Military Service Conscription Register	Carefully Matched Non-Deployed Comparators	Underwent conscription and possibly military training but not military service abroad	Sex, birth year, conscription year, psychological assessment score, cognitive ability score, and former mental health problems	Comparator group serving as benchmark when accounting for demographics, cognitive ability, psychological resources and mental health
Military Service Conscription Register	Age-Sex-Matched Non-Deployed Comparators	Underwent conscription and possibly military training but not military service abroad	Sex, birth year and conscription year	General population benchmark for death by suicide and all-cause mortality

## Introduction

### R1.2

P. 4 The first paragraph is disorienting. The introduction begins by giving details on UK military engagements but the study is about suicides in Swedish veterans. You could cite this Canadian study as another example: <http://www.forces.gc.ca/en/about-reports-pubs-health/report-on-suicide-mortality-caf-2015.page>

They found a 1.46 times higher SMR for suicide over the 35-year period in male Canadian military veterans (released Canadian Forces members with any length of service) compared to similarly aged males in the Canadian general population.

The following review of Canadian veteran population studies might be of interest:  
<http://jmvfh.utpjournals.press/doi/abs/10.3138/jmvfh.3258>

Response: We have removed most of the first paragraph to avoid the disorienting impression described by the reviewer. We have also added some of the findings from the review on the Canadian veteran population compared with the Canadian general population as well as earlier-era military veterans.

“Some countries report that their recent military veterans have worse mental health than the general population as well as earlier-era military veterans.<sup>9</sup>”

### R1.3

Note that that there is emerging evidence from the US longitudinal studies of the presence of pre-service mental health problems in recruit which are thought to predispose some individuals to mental health problems during exposure to service stressors (e.g. one of the Army STARRS studies). In the UK, the Kings College group in London published a similar finding in that mental health problems in ex-service members were more likely in those with mental health problems in service. Also evidence of higher prevalence of adverse childhood experiences in US military:  
<http://jamanetwork.com/journals/jamapsychiatry/article-abstract/1890091> and a significant literature from the US and Canada now on ACE correlations with serving members' mental health.

Response: We agree that pre-service mental health is very important to account for in analyses of suicide after military deployment. In fact, this was one of the reasons for creating our carefully matched cohort, where we account for not only history of mental health problems but also cognitive ability and psychological evaluation.

Indeed, these factors are strong risk factors for suicide both in the deployed military veteran cohort and the two comparator cohorts. This can be seen in eFigure 3 when looking at incidence rates:

individuals with psychiatric visits prior to the matching date had 2.5-5 times higher incidence of attempted suicide or death by suicide. There was also very strong gradients across cognitive ability and psychological evaluation, for example: individuals in the general population scoring  $\leq 3$  on the cognitive ability test had an incidence of 175 events per 100,000 person-years compared with 58 for those scoring 9. For psychological evaluation, the corresponding incidence rates were 212 vs 57 per 100,000 person-years (please refer to eFigure 3).

R1.4

P. 4 Last paragraph. Provide more clarity in the nature of the veteran group and the two comparator groups in the objectives. Explicitly define “veteran”. As you know, the term has many meanings internationally. This would orient the reader from the start.

RESPONSE: Please refer to the response under R2.1 and R1.1 above.

Method

R1.5 P. 5 Where is eFigure 1?

Response: The eFigures are provided in the supplementary online appendix.

R1.6

P. 6 Clarify the nature of the “veteran” and two comparator populations. The process should be transparent to readers. Consider definitions in terms of veteran, non-veteran, deployed, still-serving, released (or ex-service), and civilian (or never served), plus any other distinguishing features that a reader would need to understand. A table would help.

Response: We thank the reviewer for this excellent suggestion. We have added the following table describing the different cohorts (deployed military veterans, carefully matched non-deployed comparators, age-sex-matched non-deployed comparators):

**eTable 1**

Identification	Group	Definition	Matching factors	Purpose
Military Service Conscription Register & SWIP	Deployed Military Veterans	Deployed abroad at some time-point between 1990 and 2013	NA	To determine the rate of death by suicide and all-cause mortality among Swedish deployed military veterans
Military Service Conscription Register	Carefully Matched Non- Deployed Comparators	Underwent conscription and possibly military training but not military service abroad	Sex, birth year, conscription year, psychological assessment score, cognitive ability score, and former mental health problems	Comparator group serving as benchmark when accounting for demographics, cognitive ability, psychological resources and mental health
Military Service Conscription Register	Age-Sex-Matched Non- Deployed Comparators	Underwent conscription and possibly military training but not military service abroad	Sex, birth year and conscription year	General population benchmark for death by suicide and all-cause mortality

R1.7 I think that you sub-divided the conscript dataset into: - Those who had been conscripted and deployed. - Those who had not deployed? And then matched the non-deployers to the deployers by variables available in the conscript database, in two ways: - Matched by age and sex alone - Matched by age, sex and the other variables available in the conscript database? And then linked in cause of death data for those who could be included in the study. And then it was not clear how patient registry



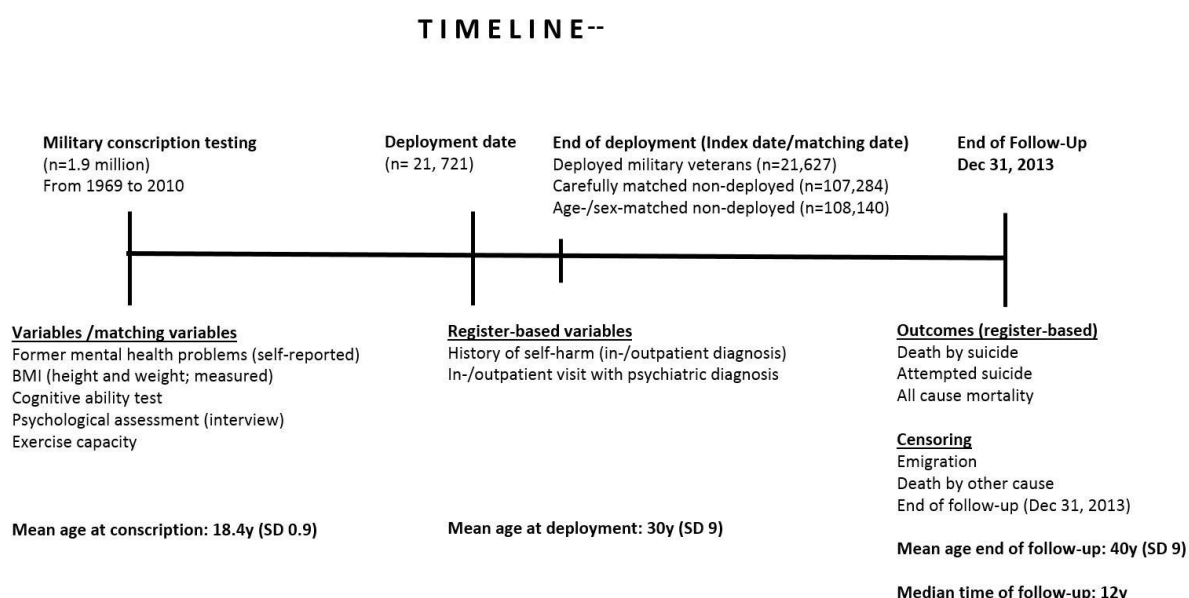
data were used. If I am wrong about this, then that might help you to revise the explanation in the Methods section.

Response: Correct. Please refer to our newly added eTable 1 which is pasted into the previous response. We hope eTable 1 will help readers to understand the design and study populations.

R1.8

P.7. What was the source of data for the variables, and at what time point were the data collected? At conscription assessment? Later in life? The Methods section needs more clarity on how the analyses were done with respect to time frames.

Response: We provide a new eFigure 2 in the appendix describing what variables that were used and from where, as well as when, they were attained:



R1.9

P. 7. Briefly explain the Stanine Scale and provide a reference.

Response: We have added a brief description and a reference for the Stanine scale (methods p7):

“The four different variables were assessed on a STANDARD-NINE scale (Stanine; from 1-9 with a normal Gaussian distribution, where 9 represents the top 4% and 1 the bottom 4%) and weighted to a G-factor value also presented on a Stanine scale.<sup>10 11</sup>”

R1.10

P. 7 The ability to detect pre-recruitment mental health issues using the national patient registry is a significant strength, presuming that it provides a complete mental health history.

Response: In the newly added eFigure 2 (see R1.8) we show how we use both self-reported mental health problems at time of military conscription and register-based assessment of mental health

through the National Patient Register. These data provide a significant strength, but it is impossible for us to claim that any data based on health care contacts (even in a country with universal health care access) would provide a complete mental health history.

R1.11 P.7 BMI based on height and weight is not an optimal measure of physical health owing to problems such as muscle mass in military personnel. Exercise capacity at recruitment is not necessarily an indicator of physical health status later in life. Is there any source of data on presence or absence of physical and mental health conditions? Consider mentioning limitations in information on physical health status in the Limitations section of the Discussion.

Response: Neither body mass or exercise capacity are optimal measures of physical health, but they are indeed good proxies for physical health in the future. We have previously evaluated both BMI, exercise capacity, and blood pressure as proxies for, for example, all cause mortality and cardiovascular disease (Neovius et al, BMJ 200912; Sundström et al, BMJ 201113; Andersen et al, BMJ 201514). We have added these references in the methods section.

Regarding source of data on physical and mental health, we use data from the National Patient Register on mental health as well as self-reported mental health at time of conscription testing. As the majority of our participants are young, few have major somatic morbidities. However, we do have data on proxies for future cardiovascular disease such blood pressure, BMI and exercise capacity. These are balanced between the groups as shown in Table 1 (blood pressure has been added in this revised version).

R1.12

P. 8 Expand on the manner in which matched comparisons were done using ANOVA and logistic regression. The phrase “conditioning on the matching set with each set consisting of one military veteran and up to 5 matched comparators” is unclear.

Response: We have revised it as follows:

“Comparison of the descriptive data of the deployed military veterans and their unmatched non-deployed comparators were performed by t-tests for continuous variables and chi-square tests for categorical variables. For conditioned comparisons of the matched cohorts ANOVA was used for continuous variables and logistic regression for categorical variables. Conditioning was made on the matching set (with each set consisting of one military veteran and up to 5 matched comparators) in order to account for the matched design.”

Results

R1.13

Owing to the lack of clarity in how the veteran and comparison groups were defined and absence of figure numbers on the figures, I had difficulty understanding the results section.

Response: Regarding definition of veteran and comparison groups, please refer to response to R2.1 and R1.1, as well as the new eTable 1.

Regarding the absence of numbers on the figures, we do not know what may have gone wrong but in the revised version all figures are labeled at the image stage so that figure numbering cannot go missing.

R1.14

The text in the Results section is too sparse I think. More explanatory information would assist readers not familiar with the procedures you used. For example, in the figure with the four event graphs, you could explain in the text “Figure \_ shows ...”. What is a “person-year” in this context?

Response: Neither the editors nor the other reviewer have made any comment regarding the style in the results section. We believe that we follow the general style used in BMJ journals and would like to refrain from any major changes.

Regarding person-years, this is the number of years of observation of individuals until event, death, emigration or end of follow-up, as explained in the methods section:

“Participants were followed from the date of return from deployment (or matching date for comparators) until death by suicide, death from other cause, emigration, or end of follow-up, whichever came first.”

R1.15 There are more figures than captions and figures are not labelled, so references to figures in the text do not match the figures provided for review, making it hard to follow the Results section.

Response: We apologize for this. In the re-submitted versions, figures were labeled at the image stage so that no problems with numbering could arise.

## Discussion

### R1.16

P. 10 First paragraph: Military veterans showed no difference compared to who and had lower risk of mortality than who?

Response: We have revised this section to clarify the contrast:

“After accounting for psychological, psychiatric and physical fitness factors, deployed military veterans showed no difference in suicide or mortality risk, in comparison to non-deployed carefully matched comparators.”

### R1.17

P. 10 First paragraph: It is unclear why the findings in the first two sentences lead to the conclusion that there is difficulty in selecting relevant comparators.

Response: We have revised the text to make it evident why it is difficult in selecting appropriate comparators in observational studies of deployed military veterans.

Most studies compare deployed military veterans with age-sex-matched comparators from the general population. While this potentially can provide guidance about whether there is a public health concern or not, it ignores the fact that individuals selected for foreign military deployment have gone through much testing resulting in the “healthy soldier effect” (a bias similar to the more widely known “healthy worker effect”). We provide data on one contrast of deployed veterans vs age-sex-matched comparators, and one versus a carefully matched comparator group where we account for many factors associated with both being selected for military service and the outcome (suicide). The text now reads:

“After accounting for psychological, psychiatric and physical fitness factors, deployed military veterans showed no difference in suicide or mortality risk in comparison to non-deployed carefully matched comparators. If only matching comparators for age and sex, deployed military veterans had a substantially lower risk of both suicide and all-cause mortality than these age- and sex-matched comparators. These results illustrate the strength of the healthy soldier effect and the difficulty in

selecting comparators for assessment of suicide and mortality risk in deployed military veterans unless detailed data are available on both deployed veterans and comparators.”

R1.18 The balance of the discussion is incomplete. More military suicide literature could be cited.

Response: We have added text and references both in the introduction and the discussion, primarily to studies from Canada and the United States.

R1.19 P. 10 In making comparisons to other studies, consider differences in methodologies, populations studied and culture.

Response: We highlight the type of comparators used (if used at all) in our comparison with other studies. We have also added in the limitations section that cultural differences as well as recruitment strategies may differ between countries and affect generalizability:

“Finally, the generalisability of our findings may be limited by cultural differences between countries, as well as differences in the population groups from which the military recruits personnel.”

R1.20 P. 10 “The Swedish study showed a 50% lower suicide risk among veterans ...” than who?

Response: This has been revised so that it now reads:

“Based on standardised mortality ratios, a previous Swedish study showed a 50% lower suicide risk among veterans deployed 1960-1999 than in the general population after taking age and sex into account...”

R1.21 P. 10 I think that that the MilCoh study found no difference with respect to deployment, but if I recall that was after adjustment. There can be more physical and mental health problems in those deployed to high risk locations than the non-deployed, but health problems and suicide also occur in non-deployed military personnel.

Response: We agree. We use two different comparator groups to see what would be expected in

1. Non-deployed general population comparators with the same cognitive, psychological and physical resources as the deployed military veterans, and

2. Non-deployed age-sex-matched comparators

Hereby we can document the natural progression of mental health and suicide in non-deployed individuals.

R1.22 P. 10 The mechanism section is incomplete. Perhaps start by reminding the reader of the main suicide finding for which you explore mechanisms. Then discuss the findings and add context from the literature. As I understand it, and I could be wrong, your data sources could not provide information on a variety of current factors that play roles in suicide beyond the presence of mental health problems such as proximal life stressors owing to social factors, economic factors, and physical health; health services access/effectiveness; help-seeking; personal predisposing factors and access to lethal means.

Response: According to the suggestion by the reviewer, we have added the main suicide finding as a start of the paragraph:

“In our main analysis, we found deployed military veterans to have lower suicide risk than the general population when only taking age and sex into account, but the difference disappeared after accounting also for baseline psychiatric, psychological and physical factors that differed between the two groups.”

Our study is not randomized (which would provide balance in both known and unknown confounding factors), neither does it have access to all known potential confounders. However, we do have access to data on multiple important risk factors associated with both selection for military deployment and the outcome (suicide) that previous studies have not had. These factors include personal predisposing factors, such as mental health (self-reported and register-assessed), cognitive ability, psychological evaluation, physical factors (exercise capacity, BMI and blood pressure) and history of self-harm. Regarding health services access, Sweden has universal health insurance. We did not have access to individuals' access to lethal means or help-seeking behavior, two factors that are difficult to measure. We have added the following to the limitations section:

“We also did not have access to data on help-seeking behavior or access to lethal means.”

For the purpose of our study, illustrating how age-sex-matched comparisons differ to a comparison accounting for psychiatric, psychological and physical resources, we believe that the mechanism section is appropriate. Also, neither the editors nor the other reviewer have yet raised concern.

R1.23 P 10 What are implications for services and policy?

Response: We have provided our thoughts on implications for research on mental as well as physical health of deployed military veterans under the heading “Implications”:

“Military veterans are a selected group of mentally healthy individuals compared to the general population. Therefore studies of mental health after foreign military deployment need to take more factors than age and sex into account for comparisons to be meaningful. Our results show how previous estimates of suicide risk in Swedish military veterans, and likely veterans in other countries, have been biased by failing to account for the greater cognitive, psychological and physical fitness of individuals selected for military deployment.”

R1.24 P. 11 The last sentence of the implications section should be moved up higher to the first paragraph in Previous Research, and expanded for clarity. What did the initial Swedish studies find?

Response: Under previous research we have already noted the following:

“These findings are difficult to interpret as it is likely that also their cohorts of deployed military veterans differ from the general population in terms of psychological, psychiatric and physical fitness.”

Under previous research, the results from both the previous Swedish study and studies from other countries are presented. Therefore we would like to refrain from moving this particular sentence from the implication section.

Conclusions

R1.25

Clarify timeline in the first sentence: when with respect to suicide were those factors measured? Where they all distal at conscription or were some proximal to suicide?

Response: Please refer to the new eFigure 2.

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Reviewer: 2 Reviewer Name: Joseph Logan Institution and Country: Centers for Disease Control and Prevention, USA Competing Interests: None declared

## OVERALL

This article “Suicide, All-Cause Mortality and The Healthy Soldier Effect: A Population-Based Matched Cohort Study” summarizes a study that compared a large cohort of military Veterans to two matched cohorts of comparators with respect to suicide mortality and all-cause mortality. Overall, the paper is well written. There are some critical pieces of information that need be clarified. Some minor editing is also needed. Comments are bulleted by section below.

## Abstract

### R2.1 Objective

Please clarify if the comparators are either matched civilian cohorts or matched veteran cohorts who did not volunteer to deploy abroad. Also, it is important for the reader to understand which groups are considered to be soldiers in this analysis. Please clarify.

Response: Thank you for this comment. We have clarified throughout the text that we compare deployed military veterans with non-deployed carefully matched comparators, as well as non-deployed age-sex-matched comparators.

In the methods section, we have added information to clarify who make up the comparator cohorts, and also the purpose of both comparator cohorts (page 6, Study population).

In the supplementary appendix, we have added a table (as suggested by reviewer 1) describing each cohort (the deployed military veteran cohort, carefully matched non-deployed comparators, and age-sex-matched non-deployed comparators). In the table we provide a definition of each cohort, what matching factors were used, and the different purpose of the two comparator cohorts.

**eTable 1**

Identification	Group	Definition	Matching factors	Purpose
Military Service Conscription Register & SWIP	Deployed Military Veterans	Deployed abroad at some time-point between 1990 and 2013	NA	To determine the rate of death by suicide and all-cause mortality among Swedish deployed military veterans
Military Service Conscription Register	Carefully Matched Non-Deployed Comparators	Underwent conscription and possibly military training but not military service abroad	Sex, birth year, conscription year, psychological assessment score, cognitive ability score, and former mental health problems	Comparator group serving as benchmark when accounting for demographics, cognitive ability, psychological resources and mental health
Military Service Conscription Register	Age-Sex-Matched Non-Deployed Comparators	Underwent conscription and possibly military training but not military service abroad	Sex, birth year and conscription year	General population benchmark for death by suicide and all-cause mortality

### R2.2

In the participants and results sections, please clarify the primary veteran group of interest inclusion definition (e.g., “only veterans who have served abroad.”). As previously stated, I was unable to determine if the authors compared veterans who served abroad versus other veterans who stayed inland or veterans who served abroad versus civilians/general population. Also, please provide details on the Ns for each group. The final sample sizes for the groups are unclear.

Response: Throughout the text, we now describe the primary group of interest as “deployed military veterans” and specify in the abstract and in the methods section that they served abroad at some point between January 1, 1990, and December 31, 2013. We also specify in the methods section that individuals who deployed prior to 1990 were not eligible to be chosen as comparators.

The number of participants in each group are outlined in the first paragraph of the results section and in Table 1.

## Introduction

### R2.3

The introduction was succinct and nicely stated. My only comment is that the introduction lacked updated references on suicide risk between US military/veteran populations and US civilians for the Iraq/Afghanistan war period.

True, the risk of suicide was lower among service members versus civilians in the Gulf War era. However, risk of suicide among US active duty service members surpassed US civilians in 2008. Suicide risk among active duty members has recently dropped below age/sex comparable civilians; however, the suicide rate among young recently discharged veterans (aged 18-24) has sharply increased and is now ten-fold higher than age comparable civilians. I recommend incorporating the recent VHA report on suicide 2001-2014 (Suicide Among Veterans and Other Americans 2001–2014).

Also, I made a suggestion in the Discussion section below that is relevant to the introduction. Some clarity in the introduction can improve the understanding of the discussion. Please read comments.

Response: We thank the reviewer for this detailed update on US active duty service members. In the introduction section, we have added the following:

“Suicide rates in military veterans may also be a moving target: the report from the US Veterans Affairs “Suicide Among Veterans and Other Americans 2001–2014” described how the risk of suicide among US active duty service members surpassed US civilians in 2008, but that it later dropped below the rate observed among civilians of comparable age and sex.<sup>8</sup> However, the overall rate masked a 10-fold higher suicide rate among 18-24 year old recently discharged veterans compared to civilians.”

## Method

### R2.4

As stated in the abstract, it appears that the entire sample includes veterans according to the opening paragraph and the ‘exposure’ of interest is ‘voluntary deployment abroad.’ If so, then the authors will not be able to determine the ‘healthy soldier effect’ if the entire population includes veterans and considered to be soldiers. The authors will only be able to examine volunteerism for deployments abroad as the main independent variable and therefore will have to control for a potential selection bias; those who volunteer for deployments abroad might simply be healthier (physically and mentally) than veterans who do not volunteer for deployments abroad.

Response: In the revised version of the manuscript, we have clarified that we compare deployed military veterans with non-deployed individuals who have undergone mandatory military conscription testing (leading us to refer to non-deployed comparators as “general population”). Most deployed veterans participating in the study (and their comparators) went through their conscription testing during the 1970s, 1980s and 1990s.

In the methods section (page 5, last para), we have described the mandatory military conscription system:

"Briefly, it contains data on all men and women going through a 2-day test protocol at military conscription, including both physical and psychological examinations. While conscription testing has been voluntary for women, only 2-3% of all Swedish men were exempt from conscription testing until 2005, in most cases because of severe disabilities or congenital disorders. After 2005 the number of conscripts dropped to about a third of each birth cohort due to political decisions. In 2010 mandatory conscription was put dormant."

R2.5

The first comparison with the comparators matched by age, sex, cognitive ability, psychological assessment, mental health problems, BMI, and deployment year is the most pure analysis of comparing volunteerism for deployments abroad versus not volunteering controlling for such selection bias; however, there could still be some unknown variables linking the volunteerism for deployments and the outcomes.

Response: We agree and have expanded on the first paragraph of the limitation section where we discuss selection bias in observational studies of military veterans. The text now reads as follows:

"We chose to match comparators by age, sex, cognitive ability, psychological evaluation, history of mental health problems, and BMI from a pool of individuals who had undergone mandatory military conscription tests. We further adjusted for history of attempted suicide and exercise capacity in order to reduce the healthy soldier effect. However, selection bias and residual confounding may have remained with deployed military veterans differing systematically from the carefully matched comparators in factors associated with the outcome."

R2.6

The authors might consider including a propensity score for volunteerism to improve the analysis. All in all, this first comparison is still the most rigorous evaluation of volunteerism for deployment abroad and if this exposure variable is interpreted as a proxy for "soldier," then it appears the authors fail to show a healthy soldier effect. If both groups are soldiers, then the analysis fails to show an association between volunteerism for deployment and the outcomes. The point of the second comparison is less clear if this group also consists entirely of veterans/soldiers. If this group is a veteran group, then the authors fail to prove the healthy soldier effect, considering everyone are veteran soldiers, and only provide evidence that those who volunteer for deployments abroad tend to be mentally and physically healthier than other veterans and therefore are less likely to experience suicidal outcomes.

Response: The different groups are described in greater detail as outlined under R2.1. Given our massive sample size of eligible comparators, we believe that our matched design is better to use than adjusting or matching for a propensity score based on the same variables.

R2.7

One picky comment is that the field of suicidology does not call a suicide death a "completed suicide" anymore. This is viewed as a pejorative way of presenting these deaths. Please change "completed suicides" to "deaths by suicide." Otherwise, the authors will run the risk of losing the readership.

Response: Thank you for bringing this to our attention. We have changed the wording throughout.

Results

R2.8 Please add sample sizes for all groups into the abstract Response: Added.

R2.9 Please relabel “completed suicides” to “deaths by suicide” Response: Relabeled.

## Discussion

### R2.10

If the last comparator is truly a general population and are not considered soldiers, but the first comparator group is considered to have included soldiers who did not voluntarily deploy, then the authors provide evidence for the healthy soldier effect but do not make a strong case for why they separated soldiers who volunteered for deployment abroad versus those who did not.

Response: Both comparator groups are considered to be created from the general population – one accounting for only age and sex, the other for demographic, cognitive, psychological, psychiatric and somatic variables. Neither comparator group are considered to consist of soldiers. We apologize for not making this clear in the previous version.

Please refer to the response to comment R2.1 for details on the changes made to clarify the comparator cohorts and their purpose.

If the first comparator group is considered to be the general population, and not soldiers, then the adjusted analysis (with all the matched variables) fails to prove the healthy soldier effect.

Response: Correct. After accounting for also cognitive, psychological, psychiatric and somatic variables, we no longer see a difference in suicide risk. We write the following in the discussion section (under mechanism):

“Given these observations regarding psychological and psychiatric characteristics, it is expected that analyses taking only age and sex into account are insufficient for assessment of suicide and mortality risk. In our analyses, the hazard ratio moved from a large and statistically significant protective effect to a non-significant effect near null.”

If all groups are in essence considered to be soldiers, then the authors provide evidence that those who select for deployment abroad are healthier, but fail to provide evidence for the healthy soldier effect because everyone in this comparison is a soldier.

Response: We compare deployed military veterans with two comparator groups from the general population (who have gone through mandatory military conscription testing).

Because these groups are still unclear with regard to who is considered a soldier, who is not, the reader cannot yet fully interpret the results and the rationale for the different comparisons. Therefore, I recommend doing a major revision to help improve the clarity of each study group and the rationale for each comparison. I also strongly encourage the authors to include text that clarifies the rationale for each comparison and the significance of each comparison in the introduction.

Response: Thank you for this valuable advice. We understand that it was difficult to follow who was a soldier and who was not. The other reviewer had the same impression. We sincerely apologize for not making this more clear in the initial version. The different groups are described in greater detail as outlined under R2.1, as well as in the new eTable 1. We hope that this makes it more clear to the reader.

## VERSION 2 – REVIEW

REVIEWER	Jim Thompson Veterans Affairs Canada, Canada.
REVIEW RETURNED	08-Feb-2017

GENERAL COMMENTS	<p>Manuscript: Suicide, all-cause mortality &amp; the health soldier effect: A population-based matched cohort study</p> <p>Reviewer: Jim Thompson MD</p> <p>DRAFT 08 February 2017</p> <p>Confidential Comments to Editor:</p> <p>Comments to Authors:</p> <p>The definitions of the veteran and comparator groups remain unclear.</p> <ol style="list-style-type: none"><li>1. I think that by “veteran” you mean “conscripts who served and were deployed”.</li><li>2. I think that the comparator group is comprised of two types of conscripts: both those who did not serve in the Swedish military and those who did serve but were not deployed, although this point is not made explicit in the abstract or the paper.</li><li>3. By your revised description of the MSCR in the Methods, it appears that the comparator group of non-deployed conscripts is not representative of the Swedish general population. Increasing precision in this point does not diminish the value of your findings but does make them clearer for the reader.</li></ol> <p>Abstract</p> <p>Define “veteran” in the abstract (e.g. “deployed Swedish military personnel), and make very clear the nature of the comparator group (e.g. conscripts who were either conscripted but did not serve or who served but were not deployed). In the conclusion, change “general population” to “other conscripts”. The sentence “To each military veteran, up to 5 comparators were matched...” is unclear. In the sentence “A secondary comparison group was matched ...”, clarify for the reader who is in that secondary comparison group.</p> <p>To demonstrate a possible solution, this is how I revised the Abstract so that I could understand the study and its findings (I have attached a track-changes version so that you can check my logic):</p> <p>Objective: To compare suicide and mortality risk in Swedish military veterans (deployed Swedish military conscripts) versus non-deployed conscripts (those who did not serve or who served and were not deployed) using two methods of adjusting for population characteristics.</p> <p>Design: Population-based matched cohort study.</p> <p>Setting: Swedish military veterans who served under NATO, EU and UN mandate between 1990-2013.</p>
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	<p>Participants:.. Conscripts were identified from the Military Service Conscription Register (1969-2013). Deployed conscripts were identified from the Swedish Military Information Personnel (SWIP) Register of foreign deployments. Of 1,882,411 eligible conscripts 21,721 had served abroad at some time between 1990 and 2013 (veterans). Non-deployed conscripts were matched to veterans in two ways: (1) by cognitive ability, psychological assessment, mental health, BMI, sex, birth-year, and conscription-year (carefully matched), with further adjustment for exercise capacity and history of suicide attempts; and (2) by only sex, birth-year and conscription-year (age and sex matched).</p> <p>Main Outcome: Suicide retrieved via linkage to the Swedish National Patient Register and Causes of Death Register until December 31, 2013.</p> <p>Results: During a median follow-up of 12 years, 39 and 211 suicides occurred in the deployed and carefully matched non-deployed conscripts respectively (15 versus 16/100,000 person-years; adjusted hazard ratio [aHR] 1.07; 95%CI 0.75-1.52; P=0.72), and 329 in the age and sex-matched non-deployed conscripts (25/100,000 person-years; aHR 0.59; 95%CI 0.42-0.82; P=0.002). There were 284 and 1444 completed or attempted suicides in the deployed and carefully matched non-deployed groups respectively (109 versus 112; aHR 0.99; 95%CI 0.88-1.13; P=0.93), and 2061 in the age and sex matched non-deployed group (158; aHR 0.69; 95%CI 0.61-0.79; P&lt;0.001). The corresponding figures for all-cause mortality for the carefully matched non-deployed conscripts were 159 vs 820 (61 versus 63; aHR 0.97; 95%CI 0.82-1.15; P=0.71), and 1289 for the age and sex-matched non-deployed conscripts (98; aHR 0.62; 95%CI 0.52-0.73; P&lt;.001).</p> <p>Conclusions: Veterans (deployed conscripts) were less likely to die by suicide compared to non-deployed conscripts matched only for age and sex but did not differ from non-deployed conscripts in suicide or mortality risk after accounting for psychological, psychiatric and physical factors.</p> <p>Introduction</p> <p>Provide a clear definition for “veteran” when the word is first used, e.g. “Mental health in military veterans (formerly deployed personnel)...” for reader clarity. The reference you cite for the last sentence (#2 Rolland’s report) only gives suicide rates for serving Canadian Armed Forces members and does not review mental health in military veterans. The reference would be the paper I cited in the first review:  <a href="http://jmvfh.utpjournals.press/doi/abs/10.3138/jmvfh.3258">http://jmvfh.utpjournals.press/doi/abs/10.3138/jmvfh.3258</a>. Note that in Canadian population research “veteran” means any former CAF member with at least one day of service, whether or not they deployed.</p> <p>Previous authors have suggested that on top of the “healthy soldier effect” there is a “healthy warrior effect”, in that while serving soldiers are more healthy than the never-served general population, serving soldiers selected for deployment are more fit than serving members who are not deployed. Although effect has been debated (see for example the 1998 exchange Kang and Bullman had with Robert Haley; and the 2009 paper by Wilson et al.). I think that your study is addressing the proposed healthy warrior effect, since the</p>
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	<p>non-deployed conscript group includes both conscripts who were rejected for service and those who went on to serve but had not deployed.</p> <p>Consider revising the last paragraph as suggested in the abstract comments above.</p> <p>Methods</p> <p>Consider revising the first paragraph using the language suggested in the abstract comments above.</p> <p>Consider also revising the “Study Population” section for further clarity based on the comments above. The word “Comparator” is too non-specific, and I don’t think that use of the phrase “general population” is accurate. It is enough think to have demonstrated that adjustment for age and sex alone is insufficient when comparing mortality rates between populations.</p> <p>eTable 1:</p> <p>Consider revising the wording in eTable 1 using the language suggested above. The use of the non-specific word “comparators” in the second column is unclear. Suggestions for that second column:</p> <ol style="list-style-type: none"> <li>1. Veterans (deployed conscripts).</li> <li>2. Conscripts who never served or served and did not deploy, carefully matched.</li> <li>3. Conscripts who never served or served and did not deploy, age-sex matched only.</li> </ol> <p>In this table, the Purposes for the second group would be “Comparator group accounting for demographics, cognitive ability, psychological resources and mental health”; and for the third group would be “Comparator group accounting for age and sex only” since it is not clear to me that conscripts are representative of the general Swedish population.</p> <p>In this table, spell out SWIP or add a footnote for that acronym.</p> <p>Results</p> <p>In the first paragraph, replace “comparators” with “conscripts who never served, or served and were not deployed” for clarity.</p> <p>Discussion</p> <p>First paragraph, again replace “comparators” with “conscripts who never served, or served and were not deployed” for clarity. The first two sentences are fine. However, I don’t think that your mortality rate risk findings in themselves demonstrate a healthy soldier effect. Add in a sentence summarizing the descriptive finding that deployed conscripts had better mental health than combined served but never deployed and never served conscripts. With that I think there is suggestive evidence of a healthy warrior effect: deployed conscripts did not have a different suicide rate when adjusting for demographic and health factors, but had better mental health which could at least partially explain the suicide rate difference found when adjusting only for age and sex.</p> <p>In the remainder of the discussion, I recommend replacing “general population” with the more precise and accurate “served but never deployed and never-served conscripts” unless you can provide clear</p>
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	<p>evidence that this group is representative of the general Swedish population.</p> <p>Conclusions</p> <p>Your findings indicate the importance of accounting for more than age and sex when comparing suicide rates between populations, and they also reflect the fact that suicide is more likely to occur in those who have mental health problems than those who do not, regardless of whether they deployed, which has important policy and clinical implications.</p> <p>The reviewer also provided a file in addition to these comments. Please contact the publisher for full details.</p>
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## VERSION 2 – AUTHOR RESPONSE

Reviewer: 1

Reviewer Name: Jim Thompson

Institution and Country: Veterans Affairs Canada, Canada.

Competing Interests: None declared.

### R1.1 Definition of veterans and comparators

The definitions of the veteran and comparator groups remain unclear.

#### R1.1.1 Definition of veterans

1. I think that by “veteran” you mean “conscripts who served and were deployed”.

**Response:** Thank you for this comment, and related comments below, regarding the need for clarification that all participants (including the deployed veterans) in the matched analyses had gone through Military Conscription Testing. We have clarified this in several sections of the manuscript.

In the matched cohorts, all individuals have gone through military conscription testing. The group “deployed military veterans” have deployed abroad, while carefully matched non-deployed comparators and age-sex-matched non-deployed comparators have not. This is described in detail in **eTable 1**, as well as in the **methods** section (please see below).

In the **abstract**, we refer to “deployed military veterans”, “carefully matched non-deployed comparators” and “age-sex-matched non-deployed comparators”. In the abstract, we also make clear that both deployed veterans and non-deployed comparators are identified from the Military Service Conscription Register.

In the first sentence in the **methods** section, we have added that participants were identified from the Military Service Conscription Register:

*“This is a population-based cohort study of suicide risk among previously deployed Swedish military personnel (deployed military veterans) and matched comparators without deployment history identified from the Military Conscription Service Register including individuals who had gone through military conscription tests but not necessarily completed military training (**eTable 1**).”*

*Further, in the **methods** section under the subheading “Study Population” we describe in the first sentence that participants were identified via the Military Service Conscription Register:*

*“Three cohorts were identified via the Military Service Conscription Register for this study, including individuals who had gone through military conscription testing but without requirement of completed military service (eFigure 2)”*

In the results section (first para, 2<sup>nd</sup> sentence), we also state that we excluded 3341 deployed military veterans due to absence of military conscription data.

**eTable 1**

Identification	Group	Definition	Matching factors	Purpose
Military Service Conscription Register & Swedish Information Personnel	Deployed Military Veterans	Deployed abroad at some time-point between 1990 and 2013; underwent conscription	NA	To determine the rate of death by suicide and all-cause mortality among Swedish deployed military veterans
Military Service Conscription Register	Carefully Matched Non-Deployed Comparators	Underwent conscription and possibly military training but not military service abroad	Sex, birth year, conscription year, psychological assessment score, cognitive ability score, and former mental health problems	Comparator group serving as benchmark when accounting for demographics, cognitive ability, psychological resources and mental health
Military Service Conscription Register	Age-Sex-Matched Non-Deployed Comparators	Underwent conscription and possibly military training but not military service abroad	Sex, birth year and conscription year	Comparator group serving as benchmark when accounting only for age and sex

### R1.1.2 Definition of comparator group

2. I think that the comparator group is comprised of two types of conscripts: both those who did not serve in the Swedish military and those who did serve but were not deployed, although this point is not made explicit in the abstract or the paper.

**Response:** Thank you for pointing this out and it should of course be made explicit. It is correct that we required *only* that data from military conscription testing were available, *not* that they had completed military service (this applies both to deployed military veterans and to non-deployed comparators).

We have added clarification regarding this in the methods section under the subheading “Study Population”, first sentence:

*“Three cohorts were identified via the Military Service Conscription Register for this study, including individuals who had gone through military conscription testing but without requirement of completed military service (eFigure 2)”*

### R1.1.3 Removal of “General population” /

3. By your revised description of the MSCR in the Methods, it appears that the comparator group of non-deployed conscripts is not representative of the Swedish general population. Increasing precision in this point does not diminish the value of your findings but does make them clearer for the reader.

**Response:** We have removed the term “general population” and rephrased it as follows:

*“The purpose of this comparator group was to provide a benchmark for death by suicide and all-cause mortality based on the whole group of individuals going through military conscription testing.”*

Throughout, we use the term “age-sex-matched non-deployed comparators” instead of “general population”.

## Abstract

**NOTE:** It appears as if the reviewer has commented and made tracked changes in the unrevised abstract version, that is the abstract from the original submission in August 2016.

### R1.2

Define “veteran” in the abstract (e.g. “deployed Swedish military personnel), and make very clear the nature of the comparator group (e.g. conscripts who were either conscripted but did not serve or who served but were not deployed). In the conclusion, change “general population” to “other conscripts”. The sentence “To each military veteran, up to 5 comparators were matched...” is unclear. In the sentence “A secondary comparison group was matched ...”, clarify for the reader who is in that secondary comparison group.

To demonstrate a possible solution, this is how I revised the Abstract so that I could understand the study and its findings (I have attached a track-changes version so that you can check my logic):

*Objective: To compare suicide and mortality risk in Swedish military veterans (deployed Swedish military conscripts) versus non-deployed conscripts (those who did not serve or who served and were not deployed) using two methods of adjusting for population characteristics.*

**Response:** *The objective now reads:*

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

*We would like to refrain from calling either the deployed veterans or the non-deployed comparators “conscripts”. While all participants have gone through military conscription testing, the mean age at deployment (and matching age for non-deployed comparators) is 27 years, while the conscription age is 18 years. Instead, we state under participants that all participants were identified via the Military Service Conscription Register.*

*Design: Population-based matched cohort study.*

*Setting: Swedish military veterans who served under NATO, EU and UN mandate between 1990-2013.*

**Response:** *The setting now reads: “Setting Sweden.”*

*Participants: Conscripts were identified from the Military Service Conscription Register (1969-2013). Deployed conscripts were identified from the Swedish Military Information Personnel (SWIP) Register of foreign deployments. Of 1,882,411 eligible conscripts 21,721 had served abroad at some time between 1990 and 2013 (veterans). Non-deployed conscripts were matched to veterans in two ways: (1) by cognitive ability, psychological assessment, mental health, BMI, sex, birth-year, and conscription-year (carefully matched), with further adjustment for exercise capacity and history of suicide attempts; and (2) by only sex, birth-year and conscription-year (age and sex matched).*

*Response: We have integrated much of the suggestions in this paragraph, although we refrain from calling the participants “conscripts”. It now reads:*

**“Participants** *Participants were identified from the Military Service Conscription Register and deployment status from the Swedish Military Information Personnel Register. Of 1.9 million eligible conscripts, 21,721 had served abroad at some time between 1990 and 2013 (deployed military veterans). Non-deployed comparators were matched to deployed military veterans in two ways: (1) by cognitive ability, psychological assessment, mental health, BMI, sex, birth-year, and conscription-year (carefully matched), with further adjustment for exercise capacity and history of suicide attempts; and (2) by only sex, birth-year and conscription-year (age-sex-matched).”*

*Main Outcome: Suicide retrieved via linkage to the Swedish National Patient Register and Causes of Death Register until December 31, 2013.*

*Results: During a median follow-up of 12 years, 39 and 211 suicides occurred in the deployed and carefully matched non-deployed conscripts respectively (15 versus 16/100,000 person-years; adjusted hazard ratio [aHR] 1.07; 95%CI 0.75-1.52; P=0.72), and 329 in the age and sex-matched non-deployed conscripts (25/100,000 person-years; aHR 0.59; 95%CI 0.42-0.82; P=0.002). There were 284 and 1444 completed or attempted suicides in the deployed and carefully matched non-deployed groups respectively (109 versus 112; aHR 0.99; 95%CI 0.88-1.13; P=0.93), and 2061 in the age and sex matched non-deployed group (158; aHR 0.69; 95%CI 0.61-0.79; P<0.001). The corresponding figures for all-cause mortality for the carefully matched non-deployed conscripts were 159 vs 820 (61 versus 63; aHR 0.97; 95%CI 0.82-1.15; P=0.71), and 1289 for the age and sex-matched non-deployed conscripts (98; aHR 0.62; 95%CI 0.52-0.73; P<.001).*

*Response: We have not inserted the term “conscripts” in the results section. The results section has been revised and now reads:*

*“Results During a median follow-up of 12 years, 39 and 211 deaths by suicide occurred in deployed military veterans (n=21,627) and carefully matched non-deployed comparators (n=107,284), respectively (15 versus 16/100,000 person-years; adjusted hazard ratio [aHR] 1.07; 95%CI 0.75-1.52; P=0.72), and 329 in age-/sex-matched non-deployed comparators (n=108,140;25/100,000 person-years; aHR 0.59; 95%CI 0.42-0.82; P=0.002). There were 284 and 1444 deaths by suicide or attempted suicides in deployed military veterans and carefully matched non-deployed comparators, respectively (109 versus 112; aHR 0.99; 95%CI 0.88-1.13; P=0.93), and 2061 in age-/sex-matched non-deployed comparators (158; aHR 0.69; 95%CI 0.61-0.79; P<0.001). The corresponding figures for all-cause mortality for carefully matched non-deployed comparators were 159 vs 820 (61 versus 63/100,000 person-years; aHR 0.97; 95%CI 0.82-1.15; P=0.71), and 1289 for age-/sex-matched non-deployed comparators (98/100,000 person-years; aHR 0.62; 95%CI 0.52-0.73; P<.001).”*

*Conclusions: Veterans (deployed conscripts) were less likely to die by suicide compared to non-deployed conscripts matched only for age and sex but did not differ from non-deployed conscripts in suicide or mortality risk after accounting for psychological, psychiatric and physical factors.*

*Response: We have removed “general population” and had in the previous revision inserted “deployed” and “non-deployed”. In order to keep the abstract within the word count, we shortened the conclusion so that it now reads:*

*“Conclusion Deployed military veterans did not differ from non-deployed comparators in suicide or mortality risk after accounting for psychological, psychiatric and physical factors.”*

## Introduction

### R1.3 Veteran definition / deployed veterans

Provide a clear definition for “veteran” when the word is first used, e.g. “Mental health in military veterans (formerly deployed personnel)...” for reader clarity. The reference you cite for the last sentence (#2 Rolland’s report) only gives suicide rates for serving Canadian Armed Forces members and does not review mental health in military veterans. The reference would be the paper I cited in the first review: <http://jmvfh.utpjournals.press/doi/abs/10.3138/jmvfh.3258>. Note that in Canadian population research “veteran” means any former CAF member with at least one day of service, whether or not they deployed.

*Response: Thank you for explaining the veteran-definition in Canada. To avoid confusion, we now use “deployed military veterans” throughout the introduction as well. Thereby we believe it is clear that we refer to individuals who have deployed. We have also changed the reference*

### R1.4 Healthy soldier and healthy warrior effect

Previous authors have suggested that on top of the “healthy soldier effect” there is a “healthy warrior effect”, in that while serving soldiers are more healthy than the never-served general population, serving soldiers selected for deployment are more fit than serving members who are not deployed.



Although effect has been debated (see for example the 1998 exchange Kang and Bullman had with Robert Haley; and the 2009 paper by Wilson et al.). I think that your study is addressing the proposed healthy warrior effect, since the non-deployed conscript group includes both conscripts who were rejected for service and those who went on to serve but had not deployed.

**Response:** Thank you for highlighting this. As the comparator groups include individuals who completed as well as did not complete military service, we interpret the potential selection bias to be a combination of the healthy soldier and healthy warrior effect:

- Healthy soldier effect: deployed military veterans versus individuals not going through military service (a mix of unfit individuals and individuals choosing to avoid military service)
- Healthy warrior effect: deployed military veterans vs individuals who had completed military training but did not deploy (a mix of unfit individuals and individuals choosing not to seek foreign military deployment)

In the text, we have added the healthy warrior effect at the following places:

Introduction: *"A potential additional selection bias termed the "healthy warrior effect" may also affect results, as military personnel selected for deployment may be in better health than those not selected."*

Discussion, subheading limitations: *"We further adjusted for history of attempted suicide and exercise capacity in order to reduce the healthy soldier **and healthy warrior** effect."*

Discussion, conclusion: *"If only taking age and sex into account, deployed military veterans displayed substantially lower risks, illustrating the impact of the healthy soldier **and healthy warrior** effect."*

Title: We have removed "healthy soldier effect" from the title, which now reads:  
*"Suicide & All-Cause Mortality in Swedish Deployed Military Veterans: A Population-Based Matched Cohort Study"*

## R1.5

Consider revising the last paragraph as suggested in the abstract comments above.

**Response:** We have revised the last paragraph so that it now reads:

*"The aim of this study was to investigate the risk of suicide among previously deployed Swedish military personnel compared to two different non-deployed matched comparator groups based on individuals who had gone through military conscription testing, one that accounted for demographic, psychological, psychiatric and physical fitness factors and one that took only age and sex into account."*

## Methods

### R1.6 First paragraph / Overview

Consider revising the first paragraph using the language suggested in the abstract comments above.

**Response:** The purpose of the first paragraph in the methods section is to give a broad overview, while details regarding the study population are provided under the subheading "Study Population". However, we have added in the first paragraph that participants were identified from the Military Service Conscription Register and that they had gone through the testing:

*"This is a population-based cohort study of suicide risk among previously deployed Swedish military personnel (deployed military veterans) and matched comparators without deployment history identified from the Military Conscription Service Register including individuals who had gone through military conscription tests but not necessarily completed military training (eTable 1)."*



### R1.7 Study population

Consider also revising the “Study Population” section for further clarity based on the comments above. The word “Comparator” is too non-specific, and I don’t think that use of the phrase “general population” is accurate. It is enough think to have demonstrated that adjustment for age and sex alone is insufficient when comparing mortality rates between populations.

#### Response:

- We have added that participants were required to have gone through conscription testing, but not required to have completed military service
- We have specified that we are investigating deployed veterans
- We have removed the term general population
- Comparator is used but only together with “age-sex-matched non-deployed comparator” or “carefully matched non-deployed comparator”. We believe that is standard language in observational studies and would like to keep it. At some places in the results, we have replaced “comparators” with the longer description suggested by the reviewer, but it has not been done throughout as it would limit readability and we do think that it is clear from the methods and the first mention in the results that these comparators went through testing but were not required to have performed the standard military service.

### R1.8 Revision of eTable 1

Consider revising the wording in eTable 1 using the language suggested above. The use of the non-specific word “comparators” in the second column is unclear. Suggestions for that second column:

1. Veterans (deployed **conscripts**)
2. **Conscripts** who never served or served and did not deploy, carefully matched.
3. **Conscripts** who never served or served and did not deploy, age-sex matched only.

**Response:** The mean age at deployment was 27 years (added in the results section), while the mean age at conscription was 18 years. We believe that describing deployed veterans and their non-deployed comparators as “conscripts” will be confusing. We believe it is better to clearly describe that both deployed military veterans and non-deployed comparators were required to have gone through military conscript testing from 1969 and onwards.

In this table, the Purposes for the second group would be “Comparator group accounting for demographics, cognitive ability, psychological resources and mental health”; and for the third group would be “Comparator group accounting for age and sex only” since it is not clear to me that conscripts are representative of the general Swedish population.

**Response:** We agree and have removed “general population”

In this table, spell out SWIP or add a footnote for that acronym.

**Response:** We agree and have spelled out SWIP

## Results

### R1.9 Specify comparators

In the first paragraph, replace “comparators” with “conscripts who never served, or served and were not deployed” for clarity.

**Response:** You are right it must be clear that all individuals had not deployed, as it is not an absolute requirement to have gone through the standard military service to deploy. We have changed it as follows:

*“For each of the remaining 21,721 deployed military veterans we attempted to carefully match up to 5 non-deployed comparators who had performed military conscription testing”*

## Discussion

### R1.10 Specify comparators

First paragraph, again replace “comparators” with “conscripts who never served, or served and were not deployed” for clarity.

**Response:** Similar to the change prompted by R1.9, we have changed it as follows:

*“... no difference in suicide or mortality risk in comparison to **non-deployed** carefully matched comparators **who had performed military conscription testing**”*

### R1.11 Healthy soldier effect & mental health

The first two sentences are fine.

However, I don't think that your mortality rate risk findings in themselves demonstrate a healthy soldier effect.

Add in a sentence summarizing the descriptive finding that deployed conscripts had better mental health than combined served but never deployed and never served conscripts. With that I think there is suggestive evidence of a healthy warrior effect: deployed conscripts did not have a different suicide rate when adjusting for demographic and health factors, but had better mental health which could at least partially explain the suicide rate difference found when adjusting only for age and sex.

**Response:** It is correct that the deployed military veterans had better mental health than the age-sex-matched non-deployed comparators.

However, they do not differ in the measured mental health variables compared with the carefully matched non-deployed comparators (psychological evaluation, cognitive ability, self-reported mental health problems, history of suicide attempts).

We have modified the sentence by removing reference to the healthy soldier effect and only highlight the selection bias problem. It now reads:

*“These results illustrate the difficulty in selecting comparators for assessment of suicide and mortality risk in deployed military veterans unless detailed data are available on both deployed veterans and comparators.”*

### R1.12 Remove “general population”

In the remainder of the discussion, I recommend replacing “general population” with the more precise and accurate “served but never deployed and never-served conscripts” unless you can provide clear evidence that this group is representative of the general Swedish population.

**Response:** We have removed all references to the “general population” and replaced it with a description of the comparators as non-deployed individuals who have gone through military conscription service testing.

## Conclusions

### R1.13 Summary

Your findings indicate the importance of accounting for more than age and sex when comparing suicide rates between populations, and they also reflect the fact that suicide is more likely to occur in those who have mental health problems than those who do not, regardless of whether they deployed, which has important policy and clinical implications.

**Response:** Thank you for this comment and yes, that is how we interpret our findings as well.

## VERSION 3 – REVIEW

<b>REVIEWER</b>	James M. Thompson MD Research Medical Advisor, Research Directorate, Veterans Affairs Canada
<b>REVIEW RETURNED</b>	02-Apr-2017

<b>GENERAL COMMENTS</b>	I have no additional substantive recommendations. Your revisions have clarified the nature of the study populations. Two small items: 1. Add a final sentence to the Conclusions in the Abstract, summarizing a key implication of your finding with respect to the important question of the role of deployment in suicide. 2. In Table 1, add symbols pointing out comparisons that are statistically significant. You list the statistically significant differences in their Results section called “Participant Characteristics” but they should be identified also in this table.
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## VERSION 3 – AUTHOR RESPONSE

Reviewer: 1

Reviewer Name: James M. Thompson MD

Institution and Country: Research Medical Advisor, Research Directorate, Veterans Affairs, Canada

Competing Interests: None declared.

I have no additional substantive recommendations. Your revisions have clarified the nature of the study populations. Two small items:

### R1.1 Key implication added in the Abstract, conclusion

1. Add a final sentence to the Conclusions in the Abstract, summarizing a key implication of your finding with respect to the important question of the role of deployment in suicide.

**COMMENT:** We have added the implication that we bring up in the discussion section so that the abstract conclusion now reads:

**Conclusion** Deployed military veterans had similar suicide or mortality risk as non-deployed comparators after accounting for psychological, psychiatric and physical factors. Studies of mental health in deployed veterans need to adjust for more factors than age and sex for comparisons to be meaningful.

### R1.2 Add symbol pointing out statistical significance in Table 1

2. In Table 1, add symbols pointing out comparisons that are statistically significant. You list the

statistically significant differences in their Results section called “Participant Characteristics” but they should be identified also in this table.

**COMMENT:** Thank you for pointing this out. We have added a symbol (\*) and a foot note in Table 1 were the results between deployed military veterans and non-deployed age-and sex-matched comparators or non-deployed carefully matched comparators are statistically proven.