Abstract

Purpose Evidence exists of an association between pre-morbid lower cognitive ability and higher risk of hospitalization for depressive disorder in civilian cohorts. The purpose of this study was to examine the relationship of cognitive ability at conscription with post-deployment depression and the influence of (1) baseline factors: age, gender, and pre-deployment educational level, (2) deployment-related factors: e.g., war-zone stress and social support, and (3) co-morbid PTSD.

Methods An observational cohort study linking conscription board registry data with post-deployment self-report data. The study population consisted of Danish Army military personnel deployed to different war zones from 1997 to 2015. The association between cognitive ability at conscription and post-deployment depression was analyzed using repeated-measure logistic regression models.

Results Study population totaled 9716 with a total of 13,371 deployments. Low-level cognitive ability at conscription was found to be weakly associated with post-deployment probable depression after adjustment for more important risk factors like gender, education, and deployment-related factors [odds ratio (OR) 0.93, 95% confidence interval (CI) 0.88–0.99]. The co-occurrence rate with PTSD was nearly 60%. When adding co-morbid PTSD as an independent variable, the association between cognitive ability and probable depression became insignificant, OR 0.95, CI 0.89–1.02.

Conclusions Low cognitive ability at conscription is a risk factor for depression among returning military personnel, but unimportant compared to gender, education, and deployment-related factors. Part of this effect may be related to co-morbid PTSD. Use of cognitive ability score as an isolated selection tool cannot be recommended because of low predictive performance.

Keywords Depression · Cognitive ability · Military · PTSD · Epidemiology

Introduction

Armed conflicts are increasingly recognized as having long-term detrimental consequences for the mental health of combatants [1]. In particular, there is substantial evidence for a link between participation in combat and post-traumatic stress disorder (PTSD) [2, 3], while the influence of military deployment on depression is less well studied. There is evidence of a PTSD-depression co-morbidity both in general [4] and when PTSD is combat-related [5]. Whether there are risk factors specifically associated with depression in a military context has only been addressed in very few studies [6, 7]. Some studies indicate, however, that deployment with combat exposure is a risk factor for new-onset major depression [8–10]. In a study of 1560 marines deployed to Iraq or
 Afghanin, five variables were found to be significantly associated with depression; combat exposure, deployment-related stressors, attitudes towards leadership, mild traumatic brain injury, and marital status [7]. As this study had a cross-sectional design, it was not possible to establish the direction of the associations.

To our knowledge, no longitudinal prospective studies have examined risk factors or vulnerability factors for depression after military deployment.

There is considerable interest in efforts to prevent post-deployment mental disorders [11]. A possible vulnerability factor is pre-deployment cognitive ability, which is tested as a part of the conscription procedures or recruit assessment programs in several countries, including Denmark [12, 13]. There is strong evidence of associations of young adult (pre-morbid) lower cognitive ability with higher risk of schizophrenia [14], and with hospitalization for other non-organic mental disorders, including major depression, which have been found in several studies [15–19]. In a questionnaire-based study, pre-deployment psychological screening has proven largely ineffective [20], while a more recent study involving pre-deployment mental health assessments by primary care providers showed that screening was associated with reduction in occupationally impairing mental health problems [11]. It is important to identify potential vulnerability factors such as cognitive ability possibly contributing to elevated risk of later psychological morbidity, as periodic mental health assessments are a part of the selection process before troops reach the battlefield [21]. We are not aware of studies that have examined the possible association between cognitive ability in young adulthood and risk of post-deployment depressive symptoms. Therefore, the overall aim of this study was to examine the influence of cognitive ability evaluated at time of conscription on the risk of post-deployment depression in a longitudinal timeframe while adjusting for other factors recorded at time of conscription and potential deployment-related risk factors such as rank, war-zone stress level, and social support.

Our primary aim was to examine the relationship between pre-deployment cognitive ability and post-deployment depression and the effect on this relationship of (1) age, gender, and educational level at the time of conscription, (2) deployment-related factors, and (3) co-morbid PTSD. The secondary aim was to examine the performance of cognitive ability as a predictor for post-deployment depression.

**Methods**

**Study design and population**

The study was an observational cohort study linking conscription board registry data with post-deployment self-reported data. The study population consisted of Danish Army military personnel deployed to different war zones including the former Yugoslavia, Iraq, and Afghanistan.

The data sources include conscription board examination data and data from the “Psychological Reactions following International Missions” (PRIM) questionnaire, which all deployed Danish Army military personnel have been invited to complete 6–8 months after deployment since 1998. The conscription board examination includes a test of cognitive ability, a physical examination, and self-reported data, e.g., on educational level. These data are from now on termed baseline variables. The PRIM database contains questionnaire data on personal characteristics, exposures during deployment, and psychological symptoms in the most recent 3 months before receiving the questionnaire, from which measures of depression and PTSD could be derived. These data are from now on termed deployment-related variables. The response rate for the PRIM questionnaire is on average 65% resulting in self-reported variables including psychological symptoms measured post-deployment from more than 21,000 deployments of about 14,600 Danish Army military personnel. Full details of the data sources and the collection of data are described in a study of the association between cognitive ability and PTSD [22]. The PRIM database has been updated, since the publication of the previous study and the present study includes deployments in the period 1997–2015.

The study population was created by merging data from the conscription board examinations and the PRIM database. A limiting prerequisite for establishing the study population was complete data on the variables (a) baseline: cognitive ability and educational level and (b) deployment-related: depression measure and PTSD measure. The study was approved by the Danish Data Protection Agency. As the study was based solely on registry and questionnaire data, no approval from the Committee on Health Research Ethics was needed.

**Exposure variable**

The baseline exposure variable was the total score on the Børge Prien’s Prøve (BPP) test of cognitive ability [13]. A score of at least 28 correct answers is a prerequisite for being fit for military service. It has been shown that BPP has a satisfactory reliability and validity [23]. In our study population, the BPP test score was converted by linear transformation to a score with mean of 100 and a standard deviation (SD) of 15 to obtain a more familiar metric. This transformed score is referred to as the cognitive ability score. This score was applied in our previous study on the association between cognitive ability and PTSD [22].
Outcome variables

The PRIM-depression scale consists of ten items addressing different symptoms of depression. The measure has been validated using Rasch models (RM) [24], and an eight-item version of the PRIM-depression scale fitted a pure RM without any differential item functioning. Thus, the eight-item PRIM-depression total score provides a sufficient statistic, and the raw score can be applied as a measure of depression [24]. To establish cut-off scores for the eight-item PRIM-depression scale for categorizing individuals with high levels of depression symptomatology, we conducted a Receiver Operating Characteristics (ROC) Curve analysis (see Supplementary material). We found a PRIM-depression score of 6 was a relevant cutoff for depression screening, that is, for identifying those, that might need further assessment or clinical attention. This category was labelled possible depression. Furthermore, we found that a PRIM-depression score of 7 was a relevant cutoff for identifying those with a likely clinical depression in this sample. This category was labelled probable depression. Probable depression had a higher positive predictive value than possible depression, while the negative predictive value was similar in both measures. Therefore, we analyzed the adjusted associations of cognitive ability with the most severe outcome, probable depression. In a sensitivity analysis, the associations were also tested using possible depression as an outcome.

Covariates

Baseline variables included age, gender, and educational level at conscription time. Educational level was coded in two categories: (1) low or middle level of schooling (primary school only and secondary school unfinished) or vocational training and (2) high level (secondary school completed or higher education).

The deployment-related variables were age at deployment, cohabiting status at deployment, military rank during deployment, perceived social support during and after deployment, and perceived war-zone stress during deployment. The variables social support, during and after deployment, and perceived war-zone stress are described elsewhere [22]. PTSD and depression are known to co-occur [4]. To assess a potential effect of co-morbid PTSD on the relationship between cognitive ability and depression, we used a dichotomous measure of PTSD as a covariate. We applied the PRIM–PTSD scale with cut-off value 29.5 (probable PTSD) [22, 25].

Statistical analysis

For study participants with multiple deployments, outcome data were correlated, and consequently data were analyzed with multi-level logistic regression models allowing for repeated measures. The explained variance of all models was evaluated using McFadden’s pseudo R-squared statistic [26]. Only variables with a Wald test $p$ value lower than 0.25 were included in the final models. Cognitive ability score was expected to correlate moderately or even strongly with educational level, because educational attainment could represent essential aspects of cognitive ability leaving open the possibility of interaction between these variables [27]. This was tested using a likelihood-ratio test.

For both outcomes (possible and probable depression), models with cognitive ability score as the main exposure variable were created. First, models including only baseline variables were conducted. Second, models including baseline variables and deployment-related variables were conducted.

As noted above, depression is a common disorder co-morbid with PTSD, and the relationship between cognitive ability and depression could be influenced by PTSD [4, 5]. Figure 1 shows a diagram showing the underlying assumptions of associations and causality between the variables of interest governing the statistical analyses with focus on the role of PTSD. In the diagram, a possible confounding effect of education and a possible mediating effect of military rank is indicated as well. To test the potential influence of PTSD on the relationship between cognitive ability and probable depression, models including probable PTSD were examined. Two models were analyzed for comparison in this context, one without and one including perceived war-zone stress (model 1 and model 2), as this variable was expected to be correlated with probable PTSD, as indicated in Fig. 1. The nature of the effect of PTSD was examined by likelihood ratio testing of interaction between this factor and cognitive ability and subsequent analysis of mediation. The analysis of whether PTSD could be regarded as a mediating...
variable was done using the principles of statistical mediation analysis in the four steps recommended by Baron and Kenny [28], that is, showing that cognitive ability is correlated with depression (step 1), showing that cognitive ability is correlated with PTSD (step 2), showing that PTSD affects depression (step 3), and finally in step 4 determining the size of the potential mediating effect by controlling the association between cognitive ability and probable depression for PTSD.

To evaluate if the cognitive ability score could be used as an indicator of potential mental vulnerability, we examined the performance of the score as a predictive test for post-deployment depression by conducting Receiver Operating Characteristics (ROC) curve analysis for both outcomes. As the test variable, we used the inverse of the cognitive ability score, because increase of the score decreases the risk of post-deployment depression.

The results are presented in the text and in tables as odds ratios (OR) with 95% confidence interval (CI). The nominal statistical significance level was 0.05. Analyses were performed in STATA 15 (Stata Corporation, College Station, Texas; http://www.stata.com).

**Results**

The study population totaled 9716 with a total of 13,371 deployments. The average age at the time of conscription was 19.6 years (sd 1.52 years).

Table 1 shows the distribution of the cognitive ability score by covariates and outcome variables and the corresponding percentage of post-deployment probable depression. The percentages of questionnaires indicating possible and probable depression were 7.9% and 4.6%, respectively.

When tested, no interaction between cognitive ability and education was found ($p = 0.47$).

Table 2 shows the adjusted OR between cognitive ability score and probable depression in a model with only baseline variables (baseline model) and in a model with both baseline and deployment-related variables included (full model). Age at conscription and age at deployment were not included in any of the models due to non-significance ($p > 0.25$). In the baseline model, a higher cognitive ability score reduced the risk of probable depression, and this was also the case in the full model after inclusion of deployment-related variables. In the latter case, the OR was 0.93, CI 0.88–0.99, $p = 0.03$.

Furthermore, Table 2 shows that gender, education, military rank, cohabiting status, social support, and perceived war-zone stress were more strongly associated with probable depression in the full model than cognitive ability. In a sensitivity analysis, similar models were run with the outcome possible depression with comparable results. In this case, though, the fully adjusted association between cognitive ability and possible depression did not reach significance: OR 0.95, CI 0.90–1.00, $p = 0.057$.

Finally, a model with outcome probable depression and with inclusion of probable PTSD as an independent variable in addition to baseline and deployment-related variables was conducted. Among those reporting probable PTSD, there were 59.8% with concurrent probable depression, whereas in those not reporting probable PTSD, only 3.14% reported probable depression. A possible interaction between PTSD and cognitive ability was tested and found not to exist ($p = 0.09$). Table 3 shows the OR of cognitive ability score in two versions of a model with inclusion of probable PTSD as an independent variable and a slightly different set of other covariates in the model versions. In addition to cognitive ability score and probable PTSD, model 1 included all other variables except for perceived war-zone stress score, and model 2 included all other variables. The inclusion of PTSD attenuated the association between cognitive ability score and probable depression considerably independent of whether perceived war-zone stress score was in the model (OR 0.94, 95% CI 0.88–1.01) or not (OR 0.95, 95% CI 0.89–1.02). A significant mediating effect of PTSD was found; approximately 42% of the effect of cognitive ability on probable depression could be attributed to probable PTSD.

ROC-curve analyses of the inverse of the cognitive ability score showed that the performance of this measure considered as an isolated test for risk of post-deployment depression was very poor for both outcomes. The results of these ROC-curve analyses are described in more detail in the online supplement.

**Discussion**

In this study, we found that young adult (baseline) cognitive ability score was significantly associated with probable depression measured post-deployment when controlled for other factors known at baseline such as age, educational level, and gender. When including deployment-related covariates in the model in addition to baseline variables, the findings were the following: the association between cognitive ability and probable depression was significant, but at a lower level than other significant factors. Female gender, lower education, lower military rank, being single, low level of perceived social support, and high level of perceived war-zone stress were found to be more important risk factors than lower cognitive ability for the occurrence of both possible and probable depression after returning from the military deployment.

When this model in addition to the factors mentioned above was adjusted for probable PTSD, the relation between cognitive ability and the probable depression was
Table 1 Distribution of cognitive ability and frequency of post-deployment probable depression by variables recorded at conscription time, deployment-related variables, and outcome variables among 9716 Danish Army military personnel

| Variables recorded at conscription time (baseline) | Study population<sup>a</sup> | Pre-deployment Cognitive ability score<sup>b</sup> | Post-deployment probable depression<sup>c</sup> |
|-------------------------------------------------|-----------------------------|-----------------------------------------------|-----------------------------------------------|
|                                                  | n<sup>a</sup>               | Mean (sd<sup>c</sup>)                          | n<sup>a</sup>                                  | %                              |
| Total population                                 | 9716                        | 100.6 (14.9)                                  | 425                                          | 4.4                            |
| Year of birth                                    |                             |                                               |                                               |                                |
| 1939–1950                                        | 172                         | 100.3 (18.0)                                  | 1                                            | 0.6                            |
| 1951–1960                                        | 436                         | 98.9 (17.6)                                   | 12                                           | 2.8                            |
| 1961–1970                                        | 32                          | 96.4 (18.6)                                   | 4                                            | 12.5                           |
| 1971–1980                                        | 4180                        | 100.3 (14.8)                                  | 157                                          | 3.8                            |
| 1981–1990                                        | 4756                        | 101.1 (14.6)                                  | 243                                          | 5.1                            |
| 1991–1994                                        | 140                         | 98.7 (14.4)                                   | 8                                            | 5.7                            |
| Gender                                           |                             |                                               |                                               |                                |
| Men                                              | 9195                        | 100.5 (14.9)                                  | 364                                          | 4.0                            |
| Women                                            | 521                         | 102.6 (14.4)                                  | 61                                           | 11.7                           |
| Educational level at time of conscription        |                             |                                               |                                               |                                |
| Low or middle level, vocational training         | 5739                        | 95.7 (14.1)                                   | 288                                          | 5.0                            |
| High                                             | 3976                        | 107.7 (13.0)                                  | 137                                          | 3.5                            |
| Variables recorded at deployment (deployment-related) | Study population<sup>d</sup> | Cognitive ability score<sup>b</sup> | Post-deployment probable depression |
|                                                  | n<sup>d</sup>               | Mean (sd<sup>d</sup>)                          | n<sup>d</sup>                                  | %                              |
| Age at deployment                                 |                             |                                               |                                               |                                |
| < 25 years                                       | 7102                        | 100.3 (14.6)                                  | 331                                          | 4.7                            |
| 25–29 years                                      | 3816                        | 99.7 (14.8)                                   | 192                                          | 5.0                            |
| 30–39 years                                      | 1550                        | 101.8 (15.3)                                  | 70                                           | 4.5                            |
| 40–49 years                                      | 336                         | 99.0 (19.2)                                   | 11                                           | 3.3                            |
| ≥ 50 years                                       | 567                         | 97.2 (17.8)                                   | 12                                           | 2.1                            |
| Military rank during deployment                  |                             |                                               |                                               |                                |
| Private                                          | 8668                        | 97.3 (14.9)                                   | 466                                          | 5.4                            |
| Non-commissioned officer, commissioned officer or civilian | 4703                | 105.4 (13.6)                                  | 150                                          | 3.2                            |
| Cohabiting status at deployment                  |                             |                                               |                                               |                                |
| Married/cohabitant                               | 7945                        | 99.9 (15.1)                                   | 310                                          | 3.9                            |
| Single                                           | 5426                        | 100.5 (14.7)                                  | 306                                          | 5.6                            |
| Social support during deployment and after homecoming |               |                                               |                                               |                                |
| Low–medium                                       | 4504                        | 99.9 (15.3)                                   | 401                                          | 8.9                            |
| High                                             | 8867                        | 100.2 (14.8)                                  | 215                                          | 2.4                            |
| Perceived war-zone stress score                  |                             |                                               |                                               |                                |
| Low                                              | 4125                        | 100.5 (15.3)                                  | 119                                          | 2.9                            |
| Medium                                           | 4407                        | 100.2 (14.8)                                  | 156                                          | 3.5                            |
| High                                             | 4839                        | 99.6 (14.8)                                   | 341                                          | 7.1                            |
no longer statistically significant, regardless of whether perceived war-zone stress was included in the model. In addition, we found that the relationship between cognitive ability and probable depression was partly mediated by PTSD.

Finally, when evaluating the isolated cognitive ability score by ROC-curve analysis as test for later occurrence post-deployment depression, the predictive performance was found to be very poor.

In Denmark, all conscripts or applicants to a military education are assessed with regard to their health, vision, hearing, and cognitive ability. In most cases, this assessment takes place in the early youth well before participation in deployments is relevant and offers the possibility of identifying vulnerability factors which could increase the risk of mental health consequences occurring as a result of the hardships during military missions. In recent years, it has become clear that pre-morbid cognitive ability is associated with the risk of later major depression [15, 17]. These findings have motivated the investigation of the relation between young adult cognitive ability and the occurrence of depression after deployment. A sufficiently predictive performance of the cognitive ability test could justify the use of this factor in a more rigorous selection strategy with the purpose to prevent the risk of post-deployment depression. However, our results indicate that even if there is a significant association between cognitive ability and the outcomes when baseline factors are adjusted for, it cannot be advised to use the cognitive ability test isolated as a decisive selection tool with regard to the risk of post-deployment depression.

In this study, the main focus was on the role of cognitive ability, but several other risk and protective factors for post-deployment depression such as education, gender, cohabiting status, social support, and perceived war-zone stress were also examined. The findings in our study population support the findings of other studies [6, 7], showing that combat exposure and deployment-related stressors were associated to post-deployment depression, and studies finding that other factors like gender, education, and rank [29] and social support [30] could be important.

The co-occurrence of PTSD and depression in the context of military deployment and combat exposure is well-established. In a meta-analysis including 57 studies of mostly civilian and some military populations, Rytwinski and co-workers found that among persons with PTSD 52% also met the criteria for depressive disorder [4]. In the present study, we found a higher, but comparable co-occurrence rate of 59.8%. On the basis of a thorough review of the literature [5], it was concluded that results of longitudinal studies indicated a causal role of PTSD in the development of co-morbid depression. It was considered less likely that pre-existing depression could be a predictor of combat-related PTSD [5]. These conclusions are supported by recent evidence, which suggests that disaster-related PTSD is a risk factor for subsequent development of postdisaster major depression [31].

Given these considerations, the inclusion of probable PTSD in the model in our study can be interpreted as introducing a major risk factor which is very predictive for probable depression. By comparing the full model for probable depression in Table 2 with model 2 in Table 3, it can be seen
that the effect of adding concurrent PTSD as an independent variable in the model is attenuation of the associations of the other variables with the outcome. In model 2, not only cognitive ability, but also military rank becomes statistically insignificant. These findings reflect the fact that the main part of those reporting high levels of symptoms compatible with depression also reported high levels of PTSD symptoms, even though the questions forming the PRIM-depression scale were non-overlapping and different from those forming the PRIM–PTSD scale. The observations, together with the mediation analysis conducted, suggest that the association found between lower cognitive ability and probable depression was partly mediated by PTSD.

**Strengths and limitations**

One major study strength is that the present study sample was large, covered deployments to multiple locations and included a broad spectrum of well-known exposures. Furthermore, it did not merely rely on self-reported and cross-sectional data, but was based on a combination of cognitive ability score data (BPP) and self-reported educational level recorded at conscription and questionnaire data recorded post-deployment. However, there may be potential limitations. The risk of post-deployment depression could be influenced by other pre-deployment factors such as personality traits (e.g., neuroticism) [32], childhood adversity and social problems in childhood [33], and pre-existing depressive disorder [11]. Data on these factors were not available in this study, but they are considered to play a minor role in this setting, given the physical and mental health requirements for military personnel. However, we have not measured the mental status before deployment; hence, the results should not be interpreted as an effect of deployment per se. The simultaneous recording of outcome measures and risk information by questionnaires could increase the covariance between the variables, for instance between perceived war-zone stress.
and depression. This challenge is present in other published large studies relating to mental health problems among military personnel after deployment [34], and correlation between self-reported exposures and effects has to be expected to some extent. In our study, we estimate the influence of this type of bias negligible. As an example, the addition of perceived war-zone stress to model 1 had little effect on the OR estimates (including PTSD) in model 2. The outcome measure in this study, the PRIM-depression scale in an eight-item version, has been shown to provide a valid tool for comparing levels of depression for deployments that differ in level of threat and combat exposure [24]. The approximately 65% response rate for the questionnaire data left open the possibility of response bias. However, we found the response rate satisfactory, since we analyzed only within-cohort associations. Finally, the study population was a post-deployment sample of military personnel and the results of the study cannot be generalised to the whole military population.

### Conclusions

Not only PTSD, but also depressive disorder should be considered a consequence of traumatic exposure which is likely to occur during military deployments [6]. Lower cognitive ability is known to be a risk factor for severe depression in the general population [15, 17], but it has not been demonstrated before that lower cognitive ability is a risk factor for probable depression among returning soldiers. However, the predictive performance of the cognitive ability test was low, and compared with other risk factors, e.g., social support and perceived war-zone stress cognitive ability is a weak risk factor. In addition, the relationship between cognitive ability and post-deployment depression was found to be partly mediated by PTSD.
Implications
Cognitive ability score at time of conscription was found to be a vulnerability factor for post-deployment depression in the presence of other risk factors, but use of cognitive ability score as an isolated selection tool cannot be recommended because of low predictive performance.

Funding This research did not receive any specific grant from funding agencies.

Compliance with ethical standards
Conflict of interest The authors declare that they have no conflict of interest.

Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

References
1. Clarke PM, Gregory R, Salomon JA (2015) Long-term disability associated with war-related experience among Vietnam veterans: retrospective Cohort Study. Med Care 53:401–408
2. Gates MA, Holowka DW, Vasterling JJ et al (2012) Posttraumatic stress disorder in veterans and military personnel: epidemiology, screening, and case recognition. Psychol Serv 9:361–382. https://doi.org/10.1037/a0027649
3. Hoge CW, Auchterlonie JL, Milliken CS (2006) Mental health problems, use of mental health services, and attrition from military service after returning from deployment to Iraq or Afghanistan. JAMA 295:1023–1032. https://doi.org/10.1001/jama.295.9.1023
4. Rytwinski NK, Scur MD, Feeny NC, Youngstrom EA (2013) The co-occurrence of major depressive disorder among individuals with posttraumatic stress disorder: a meta-analysis. J Trauma Stress 26:299–309. https://doi.org/10.1002/jts.21814
5. Stander VA, Thomsen CJ, Highfill-McRoy RM (2014) Etiology of depression comorbidity in combat-related PTSD: a review of the literature. Clin Psychol Rev 34:87–98. https://doi.org/10.1016/j.cpr.2013.12.002
6. Bonde JP, Utzon-Frank N, Bertelsen M et al (2016) Risk of depressive disorder following disasters and military deployment: a systematic review with meta-analysis. Br J Psychiatry. https://doi.org/10.1192/bjp.bp.114.157859
7. Booth-Kewley S, Highfill-McRoy RM, Larson GE et al (2012) Anxiety and depression in marines sent to war in Iraq and Afghanistan. J Nerv Ment Dis 200:749–757. https://doi.org/10.1097/NMD.0b013e31826687e7
8. Seelig AD, Jacobson IG, Smith B et al (2012) Prospective evaluation of mental health and deployment experience among women in the US Military. Am J Epidemiol 176:135–145. https://doi.org/10.1093/aje/kwr496
9. Wells TS, LeardMann CA, Fortuna SO et al (2010) A prospective study of depression following combat deployment in support of the wars in Iraq and Afghanistan. Am J Public Health 100:90–99. https://doi.org/10.2105/AJPH.2008.155432
10. Shen YC, Arkes J, Williams TV (2012) Effects of Iraq/Afghani stan deployments on major depression and substance use disorder: analysis of active duty personnel in the US military. Am J Public Health 102:80–88. https://doi.org/10.2105/AJPH.2011.300425
11. Warner CH, Appenzeller GN, Parker JR et al (2011) Effectiveness of mental health screening and coordination of in-theater care prior to deployment to Iraq: a cohort study. Am J Psychiatry 168:378–385. https://doi.org/10.1176/appi.ajp.2010.10091103
12. Kremen WS, Koenen KC, Boake C et al (2007) Pretrauma cognitive ability and risk for posttraumatic stress disorder: a twin study. Arch Gen Psychiatry 64:361–368. https://doi.org/10.1001/archpsyc.64.3.361
13. Teasdale TW (2009) The Danish Draft Board’s intelligence test, Borge Priens prove: psychometric properties and research applications through 50 years. Scand J Psychol 50:633–638. https://doi.org/10.1111/j.1467-9450.2009.00789.x
14. Khandaker GM, Barnett JH, White IR, Jones PB (2011) A quantitative meta-analysis of population-based studies of premorbid intelligence and schizophrenia. Schizophr Res 132:220–227. https://doi.org/10.1016/j.schres.2011.06.017
15. Zammit S, Allebeck P, David AS et al (2004) A longitudinal study of premorbid IQ Score and risk of developing schizophrenia, bipolar disorder, severe depression, and other nonaffective psychoses. Arch Gen Psychiatry 61:354–360. https://doi.org/10.1001/archpsychi.61.4.354
16. Mortensen EL, Sørensen HH, Jensen HH et al (2005) IQ and mental disorder in young men. Br J Psychiatry 187:407–415. https://doi.org/10.1192/bjp.187.5.407
17. Urfer-Parnas A, Lykke Mortensen E, Saebye D, Parnas J (2010) Pre-morbid IQ in mental disorders: a Danish draft-board study of 7486 psychiatric patients. Psychol Med 40:547–556. https://doi.org/10.1017/S0033291709990754
18. Mikkelsen SS, Flensborg-Madsen T, Eliassen M, Mortensen EL (2014) A longitudinal cohort study of intelligence and later hospitalisation with mental disorder. Compr Psychiatry 55:912–919. https://doi.org/10.1016/j.comppsych.2014.01.004
19. Batty GD, Mortensen EL, Andersen AN, Osler M (2005) Childhood intelligence in relation to later psychiatric disorder: evidence from a Danish birth cohort study. Br J Psychiatry 187:180–181. https://doi.org/10.1192/bjp.187.2.180
20. Rona RJ, Hooper R, Jones M et al (2006) Mental health screening in armed forces before the Iraq war and prevention of subsequent psychological morbidity: follow-up study. BMJ 333:991. https://doi.org/10.1136/bmj.38985.610949.55
21. Hyams KC (2013) Mental health screening before troop deployment: is not supported by current evidence. Br Med J 333:979–980. https://doi.org/10.1136/bmj.39023.648970.80
22. Nissen LR, Karstoft K-I, Vedtofte MS et al (2017) Cognitive ability and risk of post-traumatic stress disorder after military deployment: an observational cohort study. Br J Psychiatry Open 3:274–280. https://doi.org/10.1192/bjpo.bp.117.005736
23. Teasdale TW, Hartmann PVW, Pedersen CH, Bertelsen M (2011) The reliability and validity of the Danish Draft Board cognitive ability test: Borge Priens Prove. Scand J Psychol 52:126–130. https://doi.org/10.1111/j.1467-9450.2010.00862.x
24. Karstoft K-I, Nielsen ABS, Nielsen T (2017) Assessment of depression in veterans across missions: a validity study using Rasch measurement models. Eur J Psychotraumatol. https://doi.org/10.1080/20008198.2017.1326798
25. Karstoft K-I, Andersen SB, Nielsen ABS (2017) Assessing PTSD in the military: validation of a scale distributed to Danish soldiers after deployment since 1998. Scand J Psychol 58:e1–e9. https://doi.org/10.1111/sjop.12360
26. McFadden D (1973) Conditional logit analysis of qualitative choice behavior. Frontiers in econometrics. Academic Press, Cambridge, Massachusetts, USA, pp 105–142

27. Deary IJ, Johnson W (2010) Intelligence and education: causal perceptions drive analytic processes and therefore conclusions. Int J Epidemiol 39:1362–1369. https://doi.org/10.1093/ije/dyq072

28. Baron RM, Kenny DA (1986) The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. J Personal Soc Psychol 51:1173–1182

29. Gadermann AM, Engel CC, Naifeh JA et al (2012) Prevalence of DSM-IV major depression among U.S. military personnel: meta-analysis and simulation. Mil Med 177:47–59

30. Riviere LA, Kendall-Robbins A, McGurk D et al (2011) Coming home may hurt: Risk factors for mental ill health in US reservists after deployment in Iraq. Br J Psychiatry 198:136–142. https://doi.org/10.1192/bjp.bp.110.084863

31. North CS, Baron D, Chen AF (2018) Prevalence and predictors of postdisaster major depression: Convergence of evidence from 11 disaster studies using consistent methods. J Psychiatr Res 102:96–101. https://doi.org/10.1016/j.jpsychores.2017.12.013

32. Klein DN, Kotov R, Bufferd SJ (2011) Personality and depression: explanatory models and review of the evidence. Annu Rev Clin Psychol 7:269–295. https://doi.org/10.1146/annurev-clinpsych-032210-104540

33. Lindert J, von Ehrenstein OS, Grashow R et al (2014) Sexual and physical abuse in childhood is associated with depression and anxiety over the life course: systematic review and meta-analysis. Int J Public Health 59:359–372. https://doi.org/10.1007/s00038-013-0519-5

34. Fear NT, Jones M, Murphy D et al (2010) What are the consequences of deployment to Iraq and Afghanistan on the mental health of the UK armed forces? Lancet 6736:1–15. https://doi.org/10.1016/S0140-6736(10)60672-1