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## Abstract

**Objectives:** Older veterans may be vulnerable to mental health problems. Meta-analytic and systematic review methods sought to determine the prevalence rate of mental health disorders in older military veterans ( $\geq 65$  years).

**Methods:** Eleven studies were eligible and meta-analyses of veteran depression, substance abuse, post-traumatic stress disorder (PTSD), anxiety, dementia, bipolar disorder and schizophrenia were conducted.

**Results:** Although conducted exclusively with US veterans, higher prevalence rates of substance (5.7%) and alcohol use disorders (5.4%) in older veterans were found compared to geriatric community populations. However, the prevalence of other mental health disorders, including PTSD and depression, in older veterans did not differ substantially from community estimates.

**Conclusions:** The rates of disorder prevalence observed indicates a need for continued awareness of mental health difficulties in older veterans. In future, studies with non-US military samples using longitudinal design are required to further understand the prevalence of mental health disorders in geriatric veterans.

As life expectancy grows, the military veteran population is becoming increasingly elderly, with almost 2.2 million veterans in the United States (US) aged 80 and older (1), with similar numbers of older veterans reported in the United Kingdom (UK; 2). Older veterans may be at an increased risk of mental health disorders compared to similarly aged non-veterans. First, a significant proportion of older veterans will have been exposed to combat and may experience long-term adjustment difficulties as a result, including post-traumatic stress disorder (PTSD; 3). Second, research has found high levels of social isolation and depression in the elderly due to factors including transport and communication difficulties or poor health (3–5), and geriatric veterans can be vulnerable to isolation and loneliness (4,6). Finally, as the cohort of US veterans who served in Vietnam ages, substance abuse disorders (SUDs) may be a growing concern given the greater lifetime prevalence of SUDs in this group (7). Consistent with this, several studies have reported older veterans ( $\geq 65$  years) to experience a variety of mental health problems, including SUDs and depression (8–11). Taken together, mental health disorders in elderly veterans represent a growing public health problem given the significant impact on veteran quality of life and increased healthcare costs (12,13).

### **Purpose of the current review**

Older veterans appear to be at risk for several mental health disorders; however, research has yielded mixed findings and the prevalence rates of mental health problems in older veterans remains unclear. To address this, we present a systematic and meta-analytic review of studies examining the prevalence rate of mental health disorders in older veterans ( $\geq 65$  years) including depression, substance abuse, PTSD, anxiety, dementia, bipolar disorder and schizophrenia, to allow conclusions derived from the evidence base.

## **Method**

### **Search strategy**

A computer based search of electronic databases, including EMBASE, PubMed, PsycINFO, PILOTS, Web of Science, was conducted between November-January 2017. The search terms were mental health, geriatric and veteran (see Supplementary Table 1). We also searched reference lists of included articles and relevant review papers (e.g. 14,15) Google Scholar, issues of journals, and contacted key authors in the field to find additional studies.

### **Eligibility criteria**

Articles had to meet the following inclusion criteria: i) study group of veterans, defined as any individual who served in the Armed Forces, ii) a sample ( $N \geq 450$ ) with a mean age of  $\geq 65$  years, iii) report of current, period or lifetime estimates of mental health disorder prevalence. **Studies had to have a sample size of 450 or greater to ensure stable prevalence estimates, consistent with previous reviews (e.g., 16–18).** Articles were excluded on the following grounds:

- a) Single-case studies.
- b) Study sample selected because the participants were a targeted group (e.g. racial group) or had a specific comorbid primary physiological or psychiatric disorder (e.g. Parkinson's, dementia, etc.) as this may limit the generalizability of findings.
- c) Study participant mental health was assessed by self-report.
- d) The article was a review or only presented qualitative findings.
- e) Conference abstracts and PhD dissertations where further information or published versions could not be obtained were excluded.
- f) Studies not written in English.

Authors (VW & SAMS) independently screened articles and extracted data. A flow chart (Figure 1) shows the number of articles retrieved. The final sample consisted of eleven studies that met the inclusion criteria.

### **Data extraction**

The following data was extracted from each study: (a) author name; (b) publication year; (c) study location; (d) study design; (e) participant ethnicity; (f) participant socio-economic status (SES); (g) era of deployment (e.g. Korean War, Vietnam War, etc.); (h) gender distribution; (i) participant age; (j) assessment time points; (k) mental health disorder prevalence rate and type; (l) instruments/diagnostic criteria used; (m) sample size and (n) any sources of bias or ethical issues. The data was extracted and assessed by two authors (VW & SAMS) with any disagreements resolved following discussion and consensus.

### **Quality rating**

Two authors (VW & SAMS) independently assessed the methodological quality of included studies using a 14-item study design specific checklist (19). Checklist items include an assessment of whether: the study objective was clearly stated; the outcome measures were clearly defined, reliable and used consistently; and whether key potential confounding variables were measured and controlled for. Studies were scored depending on whether they met the specific criteria ('no'=0, 'yes'=1). Studies had to meet criteria for at least scale items three, eleven, and fourteen to receive a quality score of 'good.' A study that met criteria on two of three items received a quality rating score of 'fair', while a study that met one or none of these items received a score of 'poor.' There was strong agreement between reviewers and disagreements were resolved through consensus.

### **Statistical analysis**

As eight disorders were analysed in this review, separate meta-analyses were conducted for each disorder. Few studies included measures of disorders such as affective disorder, adjustment disorder, and psychosis ( $k=3$ ). Meaningful prevalence rates of these disorders could not be calculated and are not included in this analysis. Prevalence rates were coded into proportional effect sizes (by dividing the number of cases by the sample size). A random-effects model was chosen *a priori* to calculate the pooled prevalence of mental

disorders and 95% confidence intervals (CI). Statistical analyses were conducted using MetaXL (epigear.com). We used a double arcsine transformation to avoid unduly large weight being applied to studies with small or large prevalence (20). Cochran's Q and I<sup>2</sup> statistic were used to assess heterogeneity. Where possible, we descriptively compared study disorder prevalence estimates by demographic and study population characteristics and quality rating.

Publication bias of each of the disorder prevalence analyses was examined by creating funnel plots to provide a visual representation of the data. Rank correlation tests (21) and regression tests (22) were conducted to determine if there was any evidence of publication bias.

## Results

### Study sample

The eleven included studies dated from 2000-2016 and involved 1,612,073 participants. Participants had an average age range of 68.6 – 84.3 years, although in four cases, participant age could not be calculated from the information provided ([9, 23–25]. Most study participants were male. Seven studies reported participant marital status, with the percentage of married participants ranging from 43% (25) to 67.3% (24). Veteran combat exposure type was largely unreported, with only one study reporting that participants had served in Vietnam and/or Korea (24). Ethnic composition of the sample was reported in seven studies and these studies consisted of mostly Caucasian participants, although a substantial proportion of ethnicity data was missing in three studies (9,23,26).

Mental health diagnosis was determined by the clinician diagnosis given in the veteran's treatment file in eight studies and by diagnostic interview in three studies (see Table 1). Studies that utilised diagnostic codes from treatment files did not supply information regarding the time frame of diagnosis (e.g. diagnosed in the last two weeks, last

month, lifetime, etc.), except for DiNapoli et al. (26) who examined mental health problems newly diagnosed in the last year. Of the studies that utilised diagnostic interviews, Mohamed et al. (24) assessed veteran mental health over the last week using the Brief Symptom Index (27), while substance use was measured over the last 30 days using the Addiction Severity Index (28). Wray et al. (29) assessed depressive symptoms over the last two weeks using The Patient Health Questionnaire-9 (30) and PTSD symptoms over the last month using PTSD Patient Checklist (PCL; 31). Study characteristics and prevalence rates are reported in Tables 1 and 2.

## Depression

Veteran depression prevalence was reported in nine studies (see Table 2). The pooled prevalence of depression was 13.4% (95% CI 2.04%, 30.70%,  $Q(8)=429751.74$ ,  $p<.0001$ ,  $I^2=99.99$ ). Most estimates were between 3% and 19% of the population (Supplementary Figure 2). Two studies reported considerably higher prevalence estimates of 61.3% and 62.7% (26,29), although patients in these studies had often recently been diagnosed with a mental health disorder. The five studies reporting lower prevalence of depression largely recruited participants following non-mental health treatment (Table 1). Moreover, studies reporting lower prevalence estimates determined participant diagnosis from their treatment file. Conversely, participants were identified as meeting diagnostic criteria by Wray et al. (29) following an assessment of patient behavioural health problems. No other marked differences in participant demographic characteristics (e.g. marital status, ethnicity, SES, education attainment, etc.) were observed between high and low prevalence reporting studies.

## PTSD

Eight studies reported data on older veteran PTSD prevalence. The pooled prevalence of PTSD was 8.4% (95% CI 2.04%, 17.88%,  $Q(7)=146663.26$ ,  $p<.0001$ ,  $I^2=99.99$ ). Most PTSD estimates were between 1.0% and 22.0% (Supplementary Figure 3). Three studies

reported high PTSD prevalence (23,26,29), and five studies reported lower PTSD prevalence (range 1.0-8.8%; 8,9,24,32,33). No marked difference was observed between high and low PTSD prevalence studies in terms of study or demographic characteristics. Although, Wray et al. (29) who reported one of the highest prevalence estimates (21.9%) assessed PTSD symptoms over the last month which may have had an impact on the findings. Insufficient information was reported regarding veteran ethnic composition and education attainment to determine whether these factors influenced the results. However, studies reporting lower PTSD prevalence often had a greater number of female participants than the studies which found a higher rate of PTSD prevalence (Table 1) which may have moderated the findings. Moreover, two of the three studies reporting higher PTSD prevalence rates did not measure exposure(s) of interest continuously or assess multiple categories of exposure (26,29), which contributed negatively towards study quality ratings.

### **Substance abuse**

The pooled prevalence of veteran SUDs was 5.7% (95% CI 2.83%, 9.34%,  $Q(8)=38321.64$ ,  $p<.0001$ ,  $I^2=99.98$ ). Estimates ranged from 0.6% (24) to 15.0% (27; Supplementary Figure 4). Most estimates were between 0.6% and 4.0% of the population, and most studies whose participants had received mental health care from the Department of Veteran Affairs (VA) gave estimates between these two levels. The four studies which gave higher estimates of substance abuse prevalence (range 10.0-15.0%) comprised of samples which received general inpatient/outpatient VA treatment, rather than treatment specifically for mental health difficulties (Table 1). Mohamed et al. (24) reported a particularly low estimate of substance abuse prevalence (0.58%) and this may reflect the fact that substance use was assessed over the last 30 days in this study. Demographic variables were not related to disorder prevalence. Notably, many studies that reported the prevalence of SUDs received lower quality ratings as key potential confounding variables (e.g. medication, education



attainment, etc.) were unaccounted for; although Byers et al. (33) and Cho et al. (8) are exceptions.

## **AUD**

One study identified individuals with AUD via diagnosis using the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R/DSM-IV; 34) and six studies used International Classification of Diseases, Ninth Revision (ICD-9; 35) diagnostic codes (see Table 1) AUD was defined by studies using the diagnostic codes for AUD; for example, the ICD-9 definition includes a pathological pattern of alcohol consumption that causes serious functional impairment, characterised by impaired control over consumption and physical dependence (35). The pooled prevalence of veteran AUDs was 5.4% (95% CI 3.42%, 7.85%,  $Q(6)=7506.33$ ,  $p<.0001$ ,  $I^2=99.92$ ). Prevalence rates of AUDs ranged from 2.4-8.8% (Supplementary Figure 5). Two studies reported slightly higher prevalence rates of AUDs (23,24) and it is worth noting that the participants in these studies were recruited following mental health treatment whilst participants from the studies reporting lower prevalence rates of AUDs had received general medical treatment (Table 1). No other differences in participant demographic characteristics or measurement tool used were observed between groups.

## **Schizophrenia**

Six studies examined schizophrenia in elderly veterans. The pooled prevalence of schizophrenia was 11.2% (95% CI 3.69%, 21.69%,  $Q(5)=50053.31$ ,  $p<.0001$ ,  $I^2=99.99$ ). Most estimates were between 0.3-12.2% (Supplementary Figure 6). Two studies reported considerably higher schizophrenia prevalence of 24.9% and 43.4% (24,32) and, again, this is likely to reflect the fact that participating veterans in these studies were receiving VA mental health treatment, often due to chronic and significant mental health conditions requiring inpatient treatment.

## Bipolar

The pooled prevalence of veteran bipolar disorder was 3.9% (95% CI 1.40%, 7.33%,  $Q(6)=29711.34$ ,  $p<.0001$ ,  $I^2=99.98$ ). Prevalence estimates often ranged between 0.20-2.9% (Supplementary Figure 7), with studies whose participants had received non-mental health care from the VA reporting estimates between these two levels. Three studies reported higher prevalence rates of bipolar disorder (23,24,32) and these studies specifically recruited participants following mental health treatment. Furthermore, neither Mohamed et al. (24) or Kerfoot et al. (23) received a quality rating of ‘good’ as neither controlled for potential confounding variables, unlike studies reporting lower prevalence rates (e.g., 8,33) which must be considered when interpreting the reported bipolar disorder prevalence.

## Anxiety disorders

The prevalence rate of veteran non-PTSD anxiety disorders was 9.1% (95% CI 1.53%, 20.97%,  $Q(6)=144071.42$ ,  $p<.0001$ ,  $I^2=99.99$ ). Most prevalence estimates ranged between 2.4-7.2% (Supplementary Figure 8). Two studies reported higher prevalence rates of 24.4% and 27.8% respectively (23,26) with participants recruited following both mental health and non-mental health VA treatment. DiNapoli et al (26) reported particularly high anxiety disorder prevalence (27.8%) which could reflect the fact that patients were newly diagnosed in the last year. The studies reporting higher anxiety prevalence rates provided insufficient data regarding participant ethnicity, education attainment and participant age for these variables to be examined as moderators (23,26). Studies reporting lower rates of anxiety disorder prevalence did not differ from studies reporting higher prevalence in terms of marital status, percentage of male participant or SES.

## Dementia

Dementia prevalence was reported in six studies, with a pooled prevalence rate of 10.1% (95% CI 7.59%, 12.84%,  $Q(5)=2971.30$ ,  $p<.0001$ ,  $I^2=99.83$ ). Prevalence estimates

ranged between 5.7-19.6% (Supplementary Figure 9). Two studies examined the prevalence of dementia by participant age (23,24), with greater incidence of dementia found in older participants. Miller and Rosenheck (9) reported the lowest prevalence rate of dementia at 5.7% (see Table 1) and this may reflect the fact that the other three studies sampled veteran participants from nursing homes and those receiving mental health care. Miller & Rosenheck (9) also reported moderately higher participant SES, with 3.7% of participants receiving a VA pension and only 26.5% of participants reporting a low income.

### **Publication bias**

No evidence of publication bias was found for the PTSD, schizophrenia, depression, anxiety (non-PTSD), bipolar disorder, dementia, or AUD/SUD analyses. For all analyses, visual inspection, non-significant Egger's tests (smallest  $p=0.11$ ) and rank correlation indicated non-asymmetric funnel plots (data not shown).

## **Discussion**

The aim of this review was to examine the prevalence of mental health disorders in older veterans using meta-analytic and systematic review methods.

### **Depression**

The prevalence of depression was 13.4% with most estimates ranging between 3.0% and 19.0%. This is consistent with previous reviews that found global geriatric depression to range between 0.9-42.0% (36). Higher estimates were reported in two studies (26,29) where patients often received a new diagnosis of a mental health disorder. Geriatric mental health care training in non-mental health contexts, such as primary care, can be limited and result in decreased detection and increased misdiagnosis of depression in older patients (37). This may explain the lower prevalence rates reported in the five studies which largely recruited participants following non-mental health treatment. Wray et al. (29) also highlighted that veterans meeting criteria for depression were significantly more likely to meet criteria for

possible dementia. This is consistent with DiNapoli et al. (26) who found older veterans were more likely to have a diagnosis of depression and higher Charlson comorbidity index scores, indicative of greater burden of comorbid conditions including dementia. This may suggest that greater depression prevalence could be associated with comorbid dementia, consistent with previous reviews (38).

## **PTSD**

The pooled prevalence rate of PTSD in elderly veterans was 8.4%. This is not inconsistent with PTSD prevalence found in US, European and Australian geriatric community samples (range: 1.76-10.0%; 39–41). The included studies that reported smaller prevalence rates of PTSD often had a smaller proportion of male participants, consistent with prior studies showing that female gender is a risk factor for PTSD (42). Methodological and demographic factors did not appear to influence PTSD prevalence. Notably, few of the studies included in this review reported veteran trauma exposure, specifically whether veterans had been exposed to war-related trauma in early life or if trauma exposure was recent and non-combat related (e.g. medical emergencies, accidents, etc.). Böttche et al. (43) found that the older veterans exposed to war-related trauma in early life have higher rates of PTSD than veterans traumatised more recently; therefore, the inclusion of veteran trauma exposure type and timing in future studies is needed.

## **SUD and AUD**

The prevalence rates of SUD and AUD in elderly veterans were 5.7% and 5.4% respectively. Prevalence rates of AUD in the US elderly general population have been estimated at 2.4% (44) indicating that the prevalence of AUDs may be elevated in older veterans. Similarly, prevalence rates of SUDs in community geriatric populations have been reported at 2.2% (7,45). Our findings indicate that the prevalence of SUD/AUDs may be

higher in older veterans than civilians, consistent with previous research (46). These results highlight the potential utility of AUD/SUD screening and treatment in elderly individuals, particularly for veterans. However, these results are based exclusively on US geriatric veterans and may not be generalizable to other contexts given the greater lifetime prevalence of AUD/SUDs found in US Vietnam veterans (7). It is also possible that clinicians may screen for and thus detect SUD/AUDs in veterans more frequently than civilians which warrants additional investigation.

### **Bipolar disorder**

The prevalence estimate of bipolar disorder was 3.9%. Studies which recruited participants following non-mental health care reported bipolar disorder estimates between 0.2 and 2.9%, consistent with US non-veteran, geriatric prevalence rates (47). Mohamed et al. (24) reported the highest prevalence rate of bipolar disorder at 20.9% and this rate likely reflects the study's clinical population as geriatric bipolar disorder is more common in clinical settings (48). Notably, studies did not provided information regarding bipolar disorder age of onset. Geriatric individuals with bipolar disorder are generally categorized as either (i) those experiencing a late-life manic episode but whose bipolar disorder began in young adulthood or (ii) patients who did not experience a manic episode prior to late-life (49). As elderly individuals with late-onset bipolar disorder present with more affective episodes per year with increased episode duration and chronicity (49,50), future research should include age of disorder onset to ensure a more complete understanding of the prevalence and presentation of bipolar disorder in older veterans.

### **Schizophrenia**

The pooled prevalence of schizophrenia was 11.2%. This is higher than rates found in similarly-aged, US community samples (51,52), although some studies report that

schizophrenia may be present in 13% of all US nursing home residents (53). Considerably greater prevalence rates of schizophrenia were reported in two studies (24,32) where participants were recruited following VA mental health treatment often for severe and persistent mental illness. Therefore, these estimates are likely to reflect the clinical nature of sample.

## **Dementia**

The prevalence of dementia in older veterans was 10.7%. This is consistent with previous, US geriatric community studies (e.g., 54). The potential moderating effect of SES was also observed and studies with lower participant income reported higher dementia prevalence, consistent with past research that has found low socioeconomic status to be a risk factor for dementia (55).

## **Anxiety**

Non-PTSD anxiety disorder pooled prevalence rate was 9.1% and is consistent with similarly-aged, US community prevalence rates (41). The lower prevalence rate of veteran anxiety compared to depression found in the present review is in line with research that older age is a protective factor for anxiety but a risk factor for depression (38). Two studies reported higher veteran anxiety prevalence rates (23,26); however, many potential moderators could not be examined as insufficient data regarding participant demographic characteristics was reported. It should be noted anxiety disorder prevalence in older veterans may be higher than 9.1% given the under-recognition of anxiety in older patients by practitioners (56) and the tendency for geriatric patients to under-report or somatise anxiety symptoms (38).

## **Clinical implications**

These results tentatively suggest that the prevalence rate of AUD/SUDs is higher in older veterans than the similarly-aged civilian population. This highlights the need for continued investment in identifying older veterans with SUD/AUDs and ensuring that effective treatment programs and services for this group are available. Sundin and colleagues (57) found higher rates of alcohol consumption in the UK military than the US military; therefore, additional research is needed to determine whether increased SUD prevalence is also present in elderly non-US veterans. From a UK perspective, the results of this review whilst of considerable interest should be regarded as tentative as information from a variety of other publications (58–60) suggests substantial differences between US and UK veterans in terms of the national attitudes towards the military and veteran healthcare provision.

### **Strengths and limitations**

This review was limited by several factors. First, only published studies were included in this review which may have caused less precise prevalence estimates (61, 62). However, no evidence of publication bias was found.

Second, most included studies had a high proportion of male participants but did not typically report the incidence of mental health conditions by gender, despite substantial statistical evidence of gender as a risk factor for psychiatric disorders (63), which should be considered in future studies. Moreover, few included studies reported complete participant trauma (e.g. nature, type, time since trauma, deployment location) and demographic information, such as age, education attainment and marital status, all of which are risk factors for mental health disorders (e.g. 64). As armed conflicts can vary in terms of the social, political and cultural climate, warfare techniques and the nature of combat exposure, with subsequent implications for veteran psychological adjustment, this should be considered when interpreting the findings and we recommend this information is included in future studies.

Third, a degree of caution is needed when interpreting the prevalence rates of mental health disorders found in this study. The majority of studies did not provide adequate information regarding disorder prevalence time frames (e.g. whether mental health disorder prevalence related to the last month, last 12-months, etc.) which may have impacted the findings. Furthermore, comparisons between the mental health disorder prevalence rates found in the present study and the general population are tentative as some community studies could potentially have included veteran participants.

Fourth, studies included in this review examined mental health difficulties in veterans enrolled in VA services. As older US veterans and civilians have been found to underutilise mental health services due to perceptions of stigma and negative appraisals of mental health care (11, 33, 65), the prevalence of mental health disorders in US veterans may potentially be higher than estimated.

Finally, high heterogeneity was found across all analysis. This heterogeneity may reflect clinical differences between studies (e.g., veterans recruited following non-mental health treatment vs. veterans recruited following mental health care vs. veterans in nursing homes) as well as methodological differences. We allowed for heterogeneity by using a random effects model and described the variation between studies to account for the presence of heterogeneity.

## **Conclusions**

In conclusion, this paper presents the first comprehensive review and meta-analysis of the prevalence of eight mental health disorders in older veterans ( $\geq 65$  years). Somewhat higher prevalence rates of SUD/AUDs in older veterans were observed compared to geriatric community populations. However, the prevalence of other mental health disorders in older veterans did not differ substantially from community estimates. Given the small number of high-quality studies and high levels of heterogeneity found, only tentative conclusions



regarding the prevalence of mental health disorders in geriatric veterans can be made.

Nonetheless, the findings suggest a need for additional research into mental health difficulties and treatment for older veterans. Future research including longitudinal studies and investigations with geriatric non-US military samples are needed to better understand the prevalence of mental health conditions in older veterans.

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