





Post-traumatic stress, prevalence of temporomandibular disorders in war veterans: Systematic review with meta-analysis

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Abstract

Introduction: The physical and psychological effects of war are not always easy to detect, but they can be far-reaching and long-lasting. One of the physical effects that may result from war stress is temporomandibular disorder (TMD).

Objective: To evaluate the prevalence of TMD sign and symptoms among war veterans diagnosed with PTSD.

Methods: We systematically searched in Web of Science, PubMed and Lilacs for articles published from the inception until 30 December 2022. All documents were assessed for eligibility based on the following Population, Exposure, Comparator and Outcomes (PECO) model: (P) Participants consisted of human subjects. (E) The Exposure consisted of exposition to war. (C) The Comparison was between war veterans (subjects exposed to war) and subjects not exposed to war. (O) The Outcome consisted of presence of temporomandibular disorders sign or symptoms (we considered pain to muscle palpation in war veterans).

Results: Forty studies were identified at the end of the research. We chose only four study to draw up the present systematic study. The included subjects were 596. Among them, 274 were exposed to war, whereas the remaining 322 were not exposed to war stress. Among those exposed to war, 154 presented sign/symptoms of TMD (56.2%) whereas only 65 of those not exposed to war (20.18%). The overall effect revealed that subjects exposed to war and diagnosed with PTSD had a higher prevalence of TMD signs (pain at muscle palpation) than controls (RR 2.21; 95% CI: 1.13–4.34), showing an association PTSD war-related and TMD.

Conclusions: War can cause lasting physical and psychological damage that can lead to chronic diseases. Our results clearly demonstrated that war exposure, directly or indirectly, increases the risk of developing TMJ dysfunction and TMD sign/symptoms.

KEYWORDS

anxiety, bruxism, post-traumatic stress (PTS), stress, temporomandibular disorders (TMD), veterans, war

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1 | INTRODUCTION

Stress exposure has been linked to a variety of chronic diseases, including cardiovascular disease, neurologic diseases and mental health disorders. Chronic stress can disrupt the body's physiological processes, leading to inflammation, oxidative stress and alterations in hormones and immune function, which in turn increase the risk of developing chronic diseases.¹⁻⁴

War is a major source of stress exposure, as it involves exposure to traumatic events, fear and loss, which can result in long-term psychological distress and increase the risk of developing physical and mental health diseases.¹

The physical and psychological effects of war are not always easy to detect, but they can be far-reaching and long-lasting.⁵ One of the most common and serious of these effects is the development of chronic diseases.⁵ The psychological trauma associated with war can lead to post-traumatic stress disorders (PTSD) and other mental health issues, including anxiety and depression.^{6,7-10} Research shows that people who have experienced traumatic events such as war are more likely to develop mental health disorders.^{6,11-14}

War can have also a profound impact on physical health. One of the physical effects that may result from war stress is temporomandibular disorder (TMD). Temporomandibular disorder is a group of disorders that affect the temporomandibular joint (TMJ) and the muscles around it.^{15,16-18} It can cause a range of symptoms, such as pain, difficulty chewing, clicking or popping sounds when opening and closing the mouth, and headaches. Temporomandibular disorder is generally caused by issues in the muscles, joints and ligaments that control the jaw. It can be caused by muscle tension, grinding or clenching of the teeth, stress, arthritis or injury to the jaw or face.¹⁹⁻²² Research has shown that war stress can be a major contributing factor to TMD. Based on the results of few studies, people who have served in the military and experienced war stress are at an increased risk of developing TMD.²³⁻²⁵ This may be because stress can cause tension in the TMJ, which can lead to pain and other TMD symptoms; however, TMJ trauma could also play a role in increasing the risk of TMD in war veterans. Stress can also cause the jaw muscles to tighten, making it difficult to open and close the mouth. In order to manage TMD, it is important to reduce stress.^{26,27} This can include relaxation techniques, such as deep breathing, yoga and meditation.²⁶

It is also important to avoid activities that may cause further strain on the TMJ, such as chewing gum, nail-biting and clenching or grinding of the teeth.²⁸

Treatment for TMD may include medications, physical therapy or even surgery.²⁹ It is important to seek treatment as soon as possible, as TMD can lead to serious long-term complications. For those who have experienced war stress, it is important to be aware of the potential risks of TMD.

Herein, we aimed to evaluate the prevalence of TMD sign and symptoms among war veterans diagnosed with PTSD.

2 | MATERIALS AND METHODS

2.1 | Eligibility criteria

All documents were assessed for eligibility based on the following Population, Exposure, Comparator and Outcomes (PECO) model.³⁰

(P) Participants consisted of human subjects.

(E) The Exposure consisted of exposition to war.

(C) The Comparison was between war veterans (subjects exposed to war) and subjects not exposed to war.

(O) The Outcome consisted of the presence of temporomandibular disorders sign or symptoms (we considered pain to muscle palpation in war veterans).

Only papers providing data at the end of the intervention were included. Exclusion criteria were as follows: (1) patients suffering from any rheumatic diseases or chronic inflammatory disorders or (e.g. rheumatoid arthritis, juvenile, idiopathic arthritis, psoriatic arthritis); (2) patients suffering with fibromyalgia; (3) congenital abnormality or neoplastic conditions in the TMJ region; (4) studies including patients receiving intra-articular infiltrations or arthrocentesis as treatment; (5) studies including local pressure pain assessment; (6) cross-over study design; (7) studies written in a language different from English; (8) full-text unavailability (i.e. posters and conference abstracts); (9) studies involving animals; (10) review (topical or systematic) articles; (11) case reports/series; and (12) studies assessing TMD prevalence in subjects not exposed to war stress;

2.2 | Search strategy

We systematically searched in Web of Science, PubMed and Lilacs for articles published from the inception until 30 December 2022. We followed the strategy following the strategy reported in [Table 1](#). Furthermore, we conducted a manual search of the references as well of previous systematic reviews on a similar topic.

This systematic review was conducted according to the guidance of the Cochrane Handbook for Systematic Reviews of Interventions and the Preferred Reporting Items for Systematic Reviews (PRISMA) guidelines 2020. The systematic review protocol has been registered on the International Prospective Register of Systematic Reviews (PROSPERO) with the number CRD42022354011.

2.3 | Data extraction

These data were extracted by two reviewers (GM and RF) from the included studies using customised data extraction on a Microsoft Excel sheet. In case of disagreement, a consensus was reached through a third reviewer (MC). The following data were extracted: (1) first author; (2) year of publication; (3) nationality; (4) number of study participants (case vs controls) (5) age of study participants (case vs controls); (6) sex (female number and percentage); (7) diagnostic

TABLE 1 Search strategy.

<p><i>PubMed</i> Search: (((('armed conflicts'[MeSH Terms] OR ('armed'[All Fields] AND 'conflicts'[All Fields]) OR 'armed conflicts'[All Fields] OR 'war'[All Fields] OR ('veteran s'[All Fields] OR 'veterans'[MeSH Terms] OR 'veterans'[All Fields] OR 'veteran'[All Fields])) AND ('temporomandibular joint disorders'[MeSH Terms] OR ('temporomandibular'[All Fields] AND 'joint'[All Fields] AND 'disorders'[All Fields]) OR 'temporomandibular joint disorders'[All Fields] OR ('temporomandibular'[All Fields] AND 'disorders'[All Fields]) OR 'temporomandibular disorders'[All Fields])) NOT ('case reports'[Publication Type] OR 'case report'[All Fields])) NOT ('review'[Publication Type] OR 'review literature as topic'[MeSH Terms] OR 'review'[All Fields]) Filters: English</p> <p><i>Lilacs</i> Temporomandibular disorders [Palavras] and war [Palavras] or veterans [Palavras]</p> <p><i>Scopus</i> TITLE-ABS-KEY(((war) or (veterans)) AND (temporomandibular AND disorders))</p>
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criteria/tools used for the diagnosis of TMD; (8) prevalence in war veterans; and (9) prevalence in control subjects.

2.4 | Quality assessment

Two reviewers (GM and LL) assessed the risk of bias using Version 2 of the Cochrane risk-of-bias tool for randomised trials (RoB 2). Any disagreement was discussed until a consensus was reached with a third reviewer (MC).

2.5 | Statistical analysis

We performed the pooled analysis using the software Review Manager version 5.2.8 (Cochrane Collaboration, Copenhagen, Denmark; 2014). We measured the risk ratio (RR) between the two groups (exposed and not exposed to war). Heterogeneity among studies was evaluated by means of the Higgins Index (I^2) and the chi-squared test classified as follows: low heterogeneity (<30%), medium heterogeneity (30%–60%) and high heterogeneity (>60%).

3 | RESULTS

3.1 | Study characteristics

Forty studies were identified at the end of the research. As illustrated by the PRISMA 2020 flowchart in Figure 1, we chose only four studies to draw up the present systematic study. We excluded seven articles before the screening: six as they were reviews; one as it was a case report. The remaining articles ($n=33$) were selected for the title and abstract screening to evaluate whether they meet the PECO criteria. Thirteen articles were excluded as duplicates. Twenty

records were assessed for eligibility. Among these, 16 were excluded as the population was not exposed to war exposure to war. The included studies have been published between 2007 and 2014. The four included studies were cross-sectional in design. All these studies compared the prevalence of TMD or TMD related symptoms/signs between subjects exposed to war (with or not a diagnosis of PTSD) and those not exposed to war (and not diagnosed with PTSD). Table 2 summarises the main characteristics of all the studies included in the present systematic review (as reported in the paragraph data extraction).

3.2 | Main findings

The included subjects in this review were 596. Among them, 274 were exposed to war, whereas the remaining 322 were not exposed to war stress. Among those exposed to war, 154 presented signs/symptoms of TMD (56.2%), whereas only 65 of those not exposed to war (20.18%) reported signs or symptoms of TMD.

The number and demographic characteristics of the enrolled patients in the four studies are presented in Table 2.

Muhvic-Urek and colleagues enrolled 100 subjects, 50 exposed to war and with a diagnosis of PTSD and 50 not exposed to war and not diagnosed with PTSD (Table 3). This is the only study that applied the Research Diagnostic Criteria for Temporomandibular Disorder criteria. Patients suffering PTSD war-related presented a higher prevalence (48% vs 8%) of TMD diagnosis.²⁵ Among TMD signs/symptoms, disc displacement was present in both groups with a similar prevalence (10% vs 8%), whereas myofascial pain and arthralgia were more frequent in the exposed group (48% vs 0% and 22% vs 2%, respectively).

In both studies, Uhač and colleagues enrolled subjects exposed to war and diagnosed with PTSD.^{23,31} In that of 2006, they found that almost all the signs and symptoms evaluated were more frequent in subjects with PTSD war-related compared with the control group (subjects not exposed to war and not diagnosed with PTSD).³¹ In detail, PTSD-diagnosed patients experienced a more pronounced compromise in the active range of motion, passive range of motion and left laterotrusion. Only the PTSD war-related group referred facial pain, jaw joint pain and headache. Headache was the most intense pain reported in the PTSD group. TMJ click, pain at muscle palpation and intrameatal tenderness were also more prevalent in veterans.³²

The results of the study performed in 2011 were in line with those of the study of 2006.²³ More frequently, PTSD subjects reported at least one muscular painful location compared with the control group (93% vs 46.65%). The left lateral pterygoid site, right lateral pterygoid site and the left posterior digastric were the most frequent painful locations in the veterans group. The most frequent painful locations in the control groups were the same but in all cases with a lower frequency and intensity. Temporomandibular disorder was more frequently painful in subjects with PTSD compared with control subjects. The left posterior capsule and the right posterior capsule were the most frequent painful location in veterans.

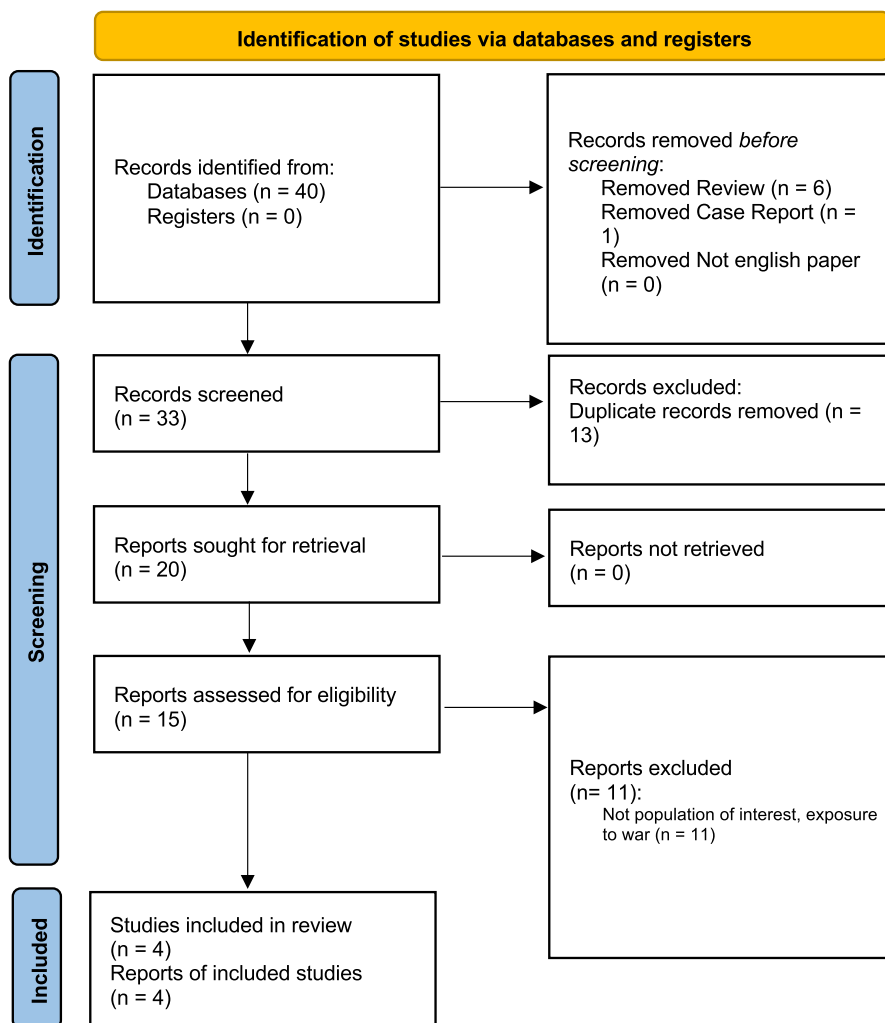


FIGURE 1 PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only. From: Page et al.⁴⁸

In the study by Mottaghi and Zamani,²⁴ 120 subjects were enrolled: 30 subjects exposed to war and diagnosed with PTSD, 30 war veterans not diagnosed with PTSD, 30 subjects not exposed to war and diagnosed with PTSD and 30 not exposed to war and not diagnosed with PTSD. Both groups of war veterans presented a higher prevalence of sign and symptoms of TMD compared with subjects not exposed to war (regardless they were diagnosed or not with PTSD). Veterans more frequent reported a history of TMJ trauma. In Table 2, we reported as cases only those exposed to war and diagnosed with PTSD, whereas veterans not diagnosed with PTSD were treated as controls. As stated above, it is interesting that regardless of diagnosis of PTSD, war exposure was associated with a higher prevalence of TMD sign and symptoms. This is the only study to explore the association between war and TMD, regardless any comorbidity.

3.3 | Meta-analysis

The meta-analysis was conducted by random model effect due to the high heterogeneity ($I^2=95\%$) among the four included studies

that compared the prevalence of TMD sign/symptoms in veterans with a diagnosis of PTSD and controls subjects (individual not exposed to war and not diagnosed with any psychiatric disorders). The outcome chosen to make comparable the four studies was the prevalence of pain at muscle palpation. The overall effect, reported in the forest plot (Figure 2), revealed that subjects exposed to war and diagnosed with PTSD had a higher prevalence of TMD signs (pain at muscle palpation) than controls (RR 2.21; 95% CI: 1.13–4.34), showing an association PTSD war-related and TMD.

3.4 | Quality assessment and risk of bias

Using the RoB 2, the risk of bias among the studies analysed was estimated and reported in Figure 3. Regarding the randomization process, all the studies ensured a high risk of bias. Allocation concealment was not applicable. Only two studies excluded a performance bias and reported all outcome data; however, none of the included studies present reporting bias. Overall, only two out of four studies were demonstrated to have a low risk of incurring bias.

TABLE 2 Main characteristics of the randomised controlled trials included in the present systematic review.

Author	year	Nationality	Number of study participants (cases vs controls)	Age of study participant, year [mean (ds)/range]		Sex (female %)	Diagnostic criteria	TMD sign/symptoms prevalence in subjects exposed to war (pain to muscle palpation)	TMD sign/symptoms prevalence in subjects not exposed to war (pain to muscle palpation)
				Cases	Controls				
Muhvic-Urek	2007	Croatia	50 vs 50	41.98 (5.78)	39.62 (7.3)	0	Research Diagnosis Criteria for Temporomandibular disorder (RDC/TMD)	24/50 (48%)	4/50 (8%)
Uhac	2006	Croatia	94 vs 88	35 (25–50)	34 (24–51)	0	Clinical examination and standard questionnaire	20/94 (21.28%)	2/88 (2.27%)
Uhac	2011	Croatia	100 vs 92	35 (24–50)	34 (24–51)	0	Palpation of the masticatory muscles, the prominent neck musculature, and TMJ	93/100 (93%)	42/92 (45.65%)
Mottaghi and Zamani	2014	Iran/Iraq	30 vs 90	40.2 (7.9)	37.9 (10.7)	0	TMJ examination that involved the clinical assessment of the TMJ signs and symptoms	17/30 (56.7%)	17/90 (15.3%)

Note: We reported the mean age of the group composed by subjects not exposed to war and not diagnosed with PTSD (that correspond to the control group in the other studies).

TABLE 3 Abbreviation used in the text.

Abbreviation	
PTSD	Post-traumatic stress disorders
TMJ	Temporomandibular joint
TMD	Temporomandibular disorders
PECO	Population Exposure Comparison Outcome

4 | DISCUSSION

Herein, we have systematically reviewed the literature to evaluate whether PTSD due to exposure to war-related stress represents a risk factor for TMD. We found that subjects exposed to war and diagnoses with PTSD present a higher risk of experience TMD. Of note, the study by Mottaghi et al. revealed that regardless of diagnosis of PTSD, war exposure was associated with a higher prevalence of TMD sign and symptoms. This is the only study exploring the association between war and TMD, regardless any comorbidity.³³

The physical and psychological effects of war are not always easy to detect, but they can be far-reaching and long-lasting.⁵ One of the most common and serious of these effects is the development of chronic diseases.³⁴ War stress can lead to an increased risk of developing chronic conditions such as cardiovascular disease, diabetes and PTSD.^{34,35} At the onset of war, adrenaline and other hormones are released to prepare the body for battle. Although this is a physiological response, when these hormones are released too often and for too long, it can have detrimental effects for the organism. Studies have

shown that long-term exposure to the hormones released during war can increase the risk of cardiovascular disease, diabetes and other chronic conditions.⁶ War stress can also have a negative effect on mental health.³⁶ The psychological trauma associated with war can lead to PTSD and other mental health issues, including anxiety and depression.³⁶ Research shows that people who have experienced traumatic events such as war are more likely to develop mental health disorders.⁶ It is important to recognise the physical and mental health effects of war. People who have experienced war-related trauma should seek help from a mental health professional, as treatment is available and can improve quality of life.^{37,38} Additionally, positive lifestyle choices such as regular exercise, healthy eating and adequate sleep can help reduce the risk of chronic disease.³⁹

Temporomandibular disorder is a group of disorders that affect the temporomandibular joint (TMJ) and the muscles around it.^{15,40} It can cause a range of symptoms, such as pain, difficulty chewing, clicking or popping sounds when opening and closing the mouth, and headaches. Temporomandibular disorder is generally caused by issues in the muscles, joints and ligaments that control the jaw. It can be caused by muscle tension, grinding or clenching of the teeth, stress, arthritis or injury to the jaw or face.⁴¹ Our study has shown that war stress can be a major contributing factor to TMD. People who have served in the military and experienced war stress are at an increased risk of developing TMD.⁴² This is because stress can cause tension in the TMJ, which can lead to pain and other TMD symptoms. Stress can also cause the jaw muscles to tighten, making it difficult to open and close the mouth. In order to manage TMD, it is important to reduce stress. This can include relaxation techniques,

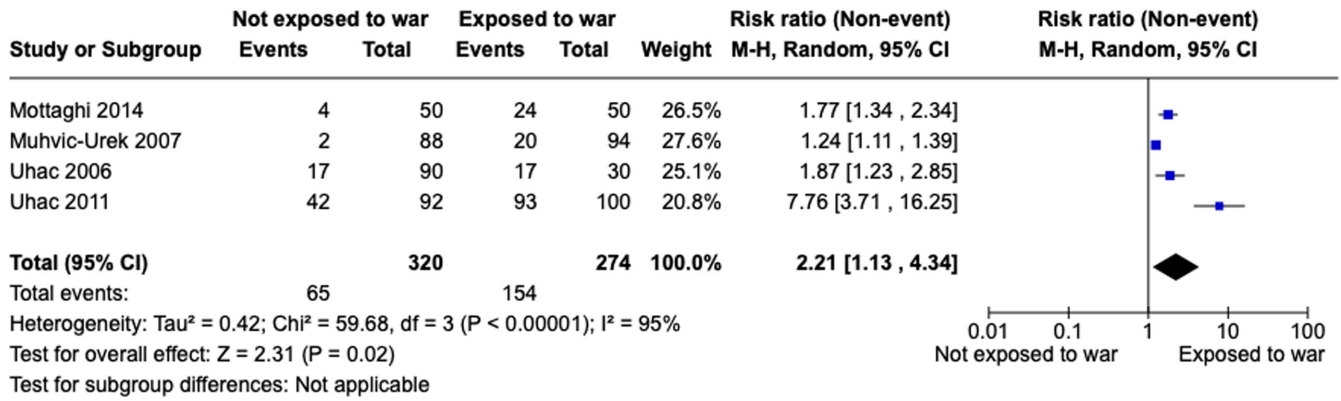
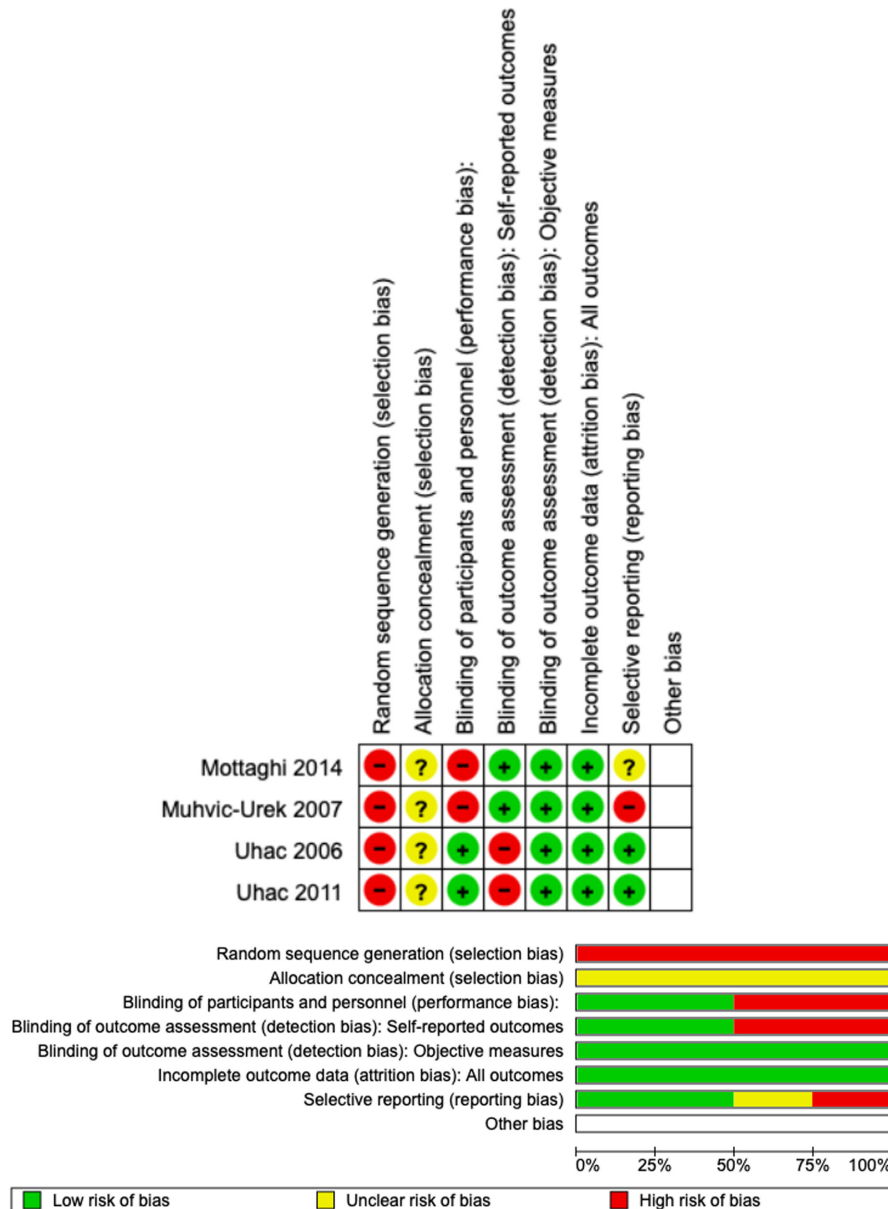


FIGURE 2 Forest plot of the meta-analysis.

FIGURE 3 Risk of bias domains.



such as deep breathing, yoga and meditation. Coping strategies, such as mindfulness practices, physical activity, social support and seeking professional help, can play an important role in managing

the symptoms and effects of chronic disease. Effective coping strategies can help individuals to better manage their symptoms, reduce stress and improve their overall quality of life.⁴³

It is also important to avoid activities that may cause further strain on the TMJ, such as chewing gum, nail-biting and clenching or grinding of the teeth.⁴⁴ If the symptoms of TMD are severe or last for more than a few weeks, it is important to seek medical attention. Treatment for TMD may include medications, physical therapy or even surgery. It is important to seek treatment as soon as possible, as TMD can lead to serious long-term complications. For those who have experienced war stress, it is important to be aware of the potential risks of TMD. By taking steps to reduce stress and seeking medical attention when needed, it is possible to manage TMD and reduce its long-term effects.

Post-traumatic stress disorder is a pathological response to stress that can occur after a person experiences or witnesses a traumatic event, during which individuals are permanently in a state of increased tension.⁴⁵ Post-traumatic stress disorders can cause a person to feel anxious, long after the event has ended.⁴⁵ The condition is accompanied by unbalance of neurotransmitters which may be directly or indirectly connected with the occurrence and course of TMD.⁴⁵ The noradrenergic system disturbances, hypothalamic-pituitary-adrenal axis alterations and disturbance in the level of serotonin could influence TMJ function by inducing muscular hyperfunction and altered pain perception.⁴⁶

There is a growing body of evidence linking psychological disturbances to an increased risk for temporomandibular disorders (TMD). Studies have found that individuals with TMD are more likely to suffer from depression, anxiety and other psychological disorders than those without TMD.⁴⁶ The exact nature of the relationship between psychological disorders and TMD is not fully understood, but there is a strong association between the two. Individuals with psychological disorders may be more likely to develop TMD because of the increased stress and anxiety they experience.⁴⁷ This stress can lead to teeth grinding (bruxism) and other habits that can damage the jaw and lead to TMD.

The main limits of this review are that (i) the included studies applied different diagnostic methods and (ii) did not exclude or correct for TMJ trauma. In this regard, studies adjusting for these confounding factors are needed to confirm the association between war-related stress exposure and TMD symptoms.

5 | CONCLUSIONS

War can cause physical and psychological damage that can lead to chronic diseases. Our results clearly demonstrated that war exposure, directly or indirectly, increases the risk of developing TMJ dysfunction and TMD sign/symptoms. People who have experienced war-related trauma should seek help from mental health professionals and make lifestyle changes to reduce the risk of developing chronic conditions.

AUTHOR CONTRIBUTIONS

Giuseppe Minervini was involved in conceptualization, methodology, software, validation, formal analysis, investigation, data curation,

writing—original draft preparation, writing—review and editing, and supervision. Rocco Franco was involved in conceptualization, software, validation and formal analysis. Maria Maddalena Marrapodi was involved in writing—original draft preparation and visualisation. Luca Fiorillo was involved in investigation and data curation. Gabriele Cervino was involved in writing—review and editing, and supervision. Marco Cicciù was involved in writing—review and editing, and supervision. All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

All data described in the study are presented in the manuscript. The data sets analysed are available from the corresponding author upon reasonable request.

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