THE MEDIATING ROLE OF POOR SLEEP QUALITY IN THE RELATIONSHIP BETWEEN POSTTRAUMATIC STRESS DISORDER AND AGGRESSION IN COMBATANTS

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Introduction. Stress-related mental disorders pose a significant risk to a patient's social, emotional, and physical well-being. One of the most vulnerable categories of the population to the development of stress-related mental disorders, including post-traumatic stress disorder, in wartime is military personnel who are constantly faced with events that threaten their lives and health. The most common complaints of combatants with PTSD include sleep disturbances and aggression. Therefore, we hypothesized that poor sleep quality may mediate the association between PTSD and aggression in combat veterans.

Methods and materials. We conducted a clinical study of 45 combatants, who were divided into the following groups: group 1 (n=24) – combatants with PTSD, and group 2 (n=21) – combatants without stress-related mental disorders. We measured sleep quality by the Pittsburgh Sleep Quality Index and aggression by the Buss-Perry Aggression Questionnaire. Statistical analysis was performed using Jamovi Desktop. The mediation analysis was performed using the medmod 1.1.0 and advanced mediation models 1.0.5.

Results. We found a strong statistically significant effect of PTSD on physical aggression (p<0.001). However, the mediating role of sleep was not found (p=0.264), as the effect of sleep disturbance on physical aggression was not confirmed (p=0.257), despite the strong effect of PTSD on sleep disturbance (p<0.001). It was found that the indirect effect of mediation through poor sleep quality accounted for 74.1% of the mediation of the relationship between PTSD and hostility. We established a partial mediation of the relationship between PTSD and aggressiveness by poor sleep quality. The direct effect accounts for 47.6% of the mediation, and the indirect effect through sleep disturbances accounts for 52.4%, which confirms the role of poor sleep quality as a mediator in this model.

Conclusions. Our findings emphasize that sleep disturbance is a significant symptom of PTSD that can affect other aspects of the disease in combatants. In this study, we demonstrate that poor sleep quality mediates hostility fully and general aggression partially in combatants with PTSD.

Key words: sleep disorders, posttraumatic stress disorder, aggression, combatants, mediation analysis.
Introduction

Stress-related mental disorders constitute a major risk to an individual’s socio-emotional and physical well-being. One of the most vulnerable categories of the population to the development of stress-related mental disorders in the context of war is military personnel who are repeatedly exposed to events that threaten their lives and health. The armed conflict in Ukraine, which has intensified as a result of Russia’s full-scale invasion of Ukraine, leads to significant psychological consequences among both civilians and combatants. The rapid deployment of many civilians into their new combat roles with little or no training makes them increasingly vulnerable to war trauma and is a risk factor for the development of mental health symptoms among active-duty military personnel. Previous studies indicate that about 12% of combatants have posttraumatic stress disorder (PTSD). The main targets for PTSD therapy are groups of core symptoms, such as intrusions, avoidance, negative changes in cognition and mood, increased excitability and reactivity, while their individual components may persist for a long time without adequate attention [6, 21].

PTSD can result in problems with impulsive aggression, which is characterized by repeated instances of verbal and/or physical aggression. Previous studies have shown that combat veterans are at increased risk of developing impulsive aggression problems after military deployment. Moreover, anger and aggression are among the most common problems reported by combatants [20].

Another common complaint among combatants is sleep disturbances (including problems falling asleep, waking up repeatedly, trouble staying asleep, and non-restorative sleep), which occur in 74% of them. Sleep disturbances have been found to predict other symptoms of PTSD. Some authors have demonstrated that sleep-oriented losses can improve the overall condition of patients with PTSD, in particular, this has been demonstrated in veterans. At the same time, sleep disturbances can act as predictors of PTSD, such as nightmares and sleep fragmentation, or remain in the form of residual insomnia, which disrupts the processes of consolidating emotional memory [16].

There are several theories explaining the connection between sleep and aggression. One of them points to a decrease in the threshold of aggression due to a reduction in the functioning of the prefrontal cortex due to poor sleep, which disrupts its inhibitory effect on emotional impulses [9]. Impaired self-inhibition, increased negative appraisals, and hostile interpretations of people’s behavior as a result of poor sleep quality are also considered as factors in aggression [10].

Currently, the relationship between poor sleep and aggression remains a matter of debate, although a growing number of studies have shown an increase in aggressive and externalizing behavior as a result of poor sleep quality. Therefore, we hypothesized that poor sleep quality may mediate the relationship between PTSD and aggression in combatants.

Materials and methods

We conducted a clinical study of 45 combatants, who were divided into the following groups: group 1 (n=24) – combatants with PTSD, and group 2 (n=21) – combatants without stress-related mental disorders. The exclusion criteria were age under 18 or over 44 years, neurological and/or mental disorders not related to stress, somatic pathology in the stage of sub- or decompensation, substance abuse or addiction in the medical history, undergoing psychotherapy or other treatments for a stress-related mental disorder or sleep disorder prior to the study. In conducting the study, we adhered to the ethical codes for scientists and doctors in Ukraine, as well as the World Health Organization’s Declaration of Helsinki. All participants in the study provided informed consent after familiarizing themselves with the purpose, duration, and details of the study. All participants underwent a clinical interview to assess the presence of PTSD or other mental disorders.

We used the Pittsburgh Sleep Quality Index to assess sleep disturbances. It contains 19 items that assess the quality of sleep over the past month. An overall score of more than 5 is considered poor sleep quality [3].

The Buss-Perry Aggression Questionnaire (BPAQ) was used to assess aggression. It consists of 29 statements, each rated on a 5-point Likert scale from 1-strongly disagree to 5-strongly agree. Items 1, 5, 9, 13, 17, 21, 27, 29, and 24 (indirectly) represent the physical aggression component (9-45 points). Items 3, 7, 11, 19, 22, 25, and 15 (indirectly) comprise the anger component (7-35 points). Items 4, 8, 12, 16, 20, 23, 26, and 28 are hostility (8-40 points). Items 2, 6, 10, 14, and 18 comprise verbal aggression (5-25 points). The total score is the sum of all scale components (29-145 points) [5].

Statistical analysis was performed using Jamovi Desktop 2.4.11. To compare the 2 groups, the T-test for independent samples and Fisher’s exact test were used. Relative risk (RR) with a 95% confidence interval (95% CI) was determined to assess the association between qualitative variables. The relationship between quantitative variables was analyzed using Pearson's correlation coefficient (r). To determine the relationships between the three variables, mediation analysis was performed using
the medmod 1.1.0 and advanced mediation models 1.0.5. Confidence intervals were computed with the Delta method. We calculated the mediation level and beta, which is a completely standardized effect size. Effect sizes between 0.10-0.29 are considered as small, effect sizes between 0.30-0.49 as medium, and effect sizes of 0.50 or greater as large [13, 15].

**Results**

We analyzed the severity of aggression in combatants with or without PTSD (Table 1).

<table>
<thead>
<tr>
<th>Subscales</th>
<th>Group 1 (n=24)</th>
<th>Group 2 (n=21)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical aggression</td>
<td>29.3±10.1</td>
<td>15.9±4.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Anger</td>
<td>20.5±2.5</td>
<td>20.4±2.3</td>
<td>0.974</td>
</tr>
<tr>
<td>Hostility</td>
<td>25.5±7.5</td>
<td>18.0±10.1</td>
<td>0.006</td>
</tr>
<tr>
<td>Verbal Aggression</td>
<td>11.1±3.5</td>
<td>10.0±3.3</td>
<td>0.310</td>
</tr>
<tr>
<td>Overall BPAQ score</td>
<td>86.4±13.1</td>
<td>64.4±10.6</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

The level of physical aggression, hostility, and total BPAQ score were higher in group 1 compared to group 2. At the same time, there were no statistically significant differences between the groups in the levels of anger and verbal aggression.

The mean PSQI score in group 1 was higher compared to group 2 (5.3±2.1 vs. 11.9±4.3, p<0.001). The prevalence of poor sleep quality in the study groups is shown below (Fig. 1).

In group 1, poor sleep quality was found in 22 (91.7%) people, and in group 2 - in 9 (42.9%). It was found that the risk of poor sleep quality increases almost 7 times in the case of PTSD (RR=6.86, 95% CI 1.73-27.2, p<0.001).

To analyze the relationship between aggression and sleep disturbance, a correlation analysis was performed (Fig. 2).
We found that the severity of sleep disturbance according to the PSQI scale has a direct moderate correlation with the level of physical aggression ($r=0.621$, $p<0.001$) and the level of hostility ($r=0.660$, $p<0.001$). The overall level of aggression demonstrated a strong direct correlation with the overall PSQI score ($r=0.793$, $p<0.001$).

For mediation analysis, we used associated variables. It was performed the mediation analysis of sleep disturbance in the relationship between PTSD and physical aggression (table 2).

### Table 2. The mediating role of poor sleep quality in relationships between PTSD and physical aggression

<table>
<thead>
<tr>
<th>Type</th>
<th>Effect</th>
<th>Estimate</th>
<th>SE</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
<th>$\beta$</th>
<th>z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect</td>
<td>PTSD1 $\Rightarrow$ PSQI overall score $\Rightarrow$ Physical aggression</td>
<td>2.543</td>
<td>2.275</td>
<td>-1.915</td>
<td>7.00</td>
<td>0.123</td>
<td>1.12</td>
<td>0.264</td>
</tr>
<tr>
<td>Component</td>
<td>PTSD1 $\Rightarrow$ PSQI overall score $\Rightarrow$ Physical aggression</td>
<td>6.583</td>
<td>1.002</td>
<td>4.619</td>
<td>8.55</td>
<td>0.700</td>
<td>6.57</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Component</td>
<td>PSQI overall score $\Rightarrow$ Physical aggression</td>
<td>0.386</td>
<td>0.340</td>
<td>-0.281</td>
<td>1.05</td>
<td>0.176</td>
<td>1.13</td>
<td>0.257</td>
</tr>
<tr>
<td>Direct</td>
<td>PTSD1 $\Rightarrow$ Physical aggression</td>
<td>10.933</td>
<td>3.204</td>
<td>4.653</td>
<td>17.21</td>
<td>0.531</td>
<td>3.41</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total</td>
<td>PTSD1 $\Rightarrow$ Physical aggression</td>
<td>13.476</td>
<td>2.348</td>
<td>8.873</td>
<td>18.08</td>
<td>0.654</td>
<td>5.74</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

We found a strong statistically significant effect of PTSD on physical aggression ($p<0.001$). However, the mediating role of sleep was not found ($p=0.264$), as the effect of sleep disturbance on physical aggression was not confirmed ($p=0.257$), despite the strong effect of PTSD on sleep disturbance ($p<0.001$).

The mediating role of sleep disturbance in the relationship between PTSD and hostility is presented below (Table 3).
Table 3. The mediating role of poor sleep quality in relationships between PTSD and hostility

<table>
<thead>
<tr>
<th>Type</th>
<th>Effect</th>
<th>Estimate</th>
<th>SE</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
<th>β</th>
<th>z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect</td>
<td>PTSD1 ⇒ PSQI overall score ⇒ Hostility</td>
<td>6.96</td>
<td>2.292</td>
<td>2.463</td>
<td>11.45</td>
<td>0.381</td>
<td>3.034</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>PSQI overall score ⇒ Hostility</td>
<td>6.58</td>
<td>1.002</td>
<td>4.619</td>
<td>8.55</td>
<td>0.700</td>
<td>6.567</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Component</td>
<td>PTSD1 ⇒ PSQI overall score</td>
<td>1.06</td>
<td>0.309</td>
<td>0.451</td>
<td>1.66</td>
<td>0.545</td>
<td>3.421</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Direct</td>
<td>PTSD1 ⇒ hostility</td>
<td>2.44</td>
<td>2.906</td>
<td>-3.259</td>
<td>8.13</td>
<td>0.134</td>
<td>0.839</td>
<td>0.402</td>
</tr>
<tr>
<td>Total</td>
<td>PTSD1 ⇒ hostility</td>
<td>9.39</td>
<td>2.358</td>
<td>4.772</td>
<td>14.01</td>
<td>0.515</td>
<td>3.984</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

We found that when sleep disturbance was added to the model as a mediator, the effect of PTSD on hostility dropped (p=0.402). At the same time, the total effect of PTSD on hostility was strong (p<0.001), which was due to the indirect effect of sleep disturbance (p=0.002). We demonstrated that PTSD has a strong effect on sleep disturbance (p<0.001), which has a strong effect on hostility (p<0.001). Thus, we established a full mediation of the relationship between PTSD and hostility through poor sleep quality (Fig. 3).

![Figure 3. Full mediation model of the relationship between PTSD and hostility by poor sleep quality](image)

It was found that the indirect effect of mediation through poor sleep quality accounted for 74.1% of the mediation of the relationship between PTSD and hostility.

The analysis of the mediating role of poor sleep quality in the relationship between PTSD and the overall level of aggression is presented below (Table 4).

Table 4. The mediating role of poor sleep quality in relationships between PTSD and aggression

<table>
<thead>
<tr>
<th>Type</th>
<th>Effect</th>
<th>Estimate</th>
<th>SE</th>
<th>Lower</th>
<th>Upper</th>
<th>β</th>
<th>z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect</td>
<td>PTSD1 ⇒ PSQI overall score ⇒ BPAQ overall score</td>
<td>11.56</td>
<td>3.448</td>
<td>4.800</td>
<td>18.31</td>
<td>0.359</td>
<td>3.35</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Component</td>
<td>PTSD1 ⇒ PSQI overall score</td>
<td>6.58</td>
<td>1.002</td>
<td>4.619</td>
<td>8.55</td>
<td>0.700</td>
<td>6.57</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>PSQI overall score ⇒ BPAQ overall score</td>
<td>1.76</td>
<td>0.450</td>
<td>0.873</td>
<td>2.64</td>
<td>0.513</td>
<td>3.90</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Direct</td>
<td>PTSD1 ⇒ BPAQ overall score</td>
<td>10.48</td>
<td>4.238</td>
<td>2.173</td>
<td>18.78</td>
<td>0.325</td>
<td>2.47</td>
<td>0.013</td>
</tr>
<tr>
<td>Total</td>
<td>PTSD1 ⇒ BPAQ overall score</td>
<td>22.04</td>
<td>3.542</td>
<td>15.093</td>
<td>28.98</td>
<td>0.684</td>
<td>6.22</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

We found a moderate indirect effect (p<0.001), which was due to a strong effect of PTSD on sleep disturbances (p<0.001) and a strong effect of poor sleep quality on aggression (p<0.001). At the same time, there was a moderate direct effect of PTSD on aggression (p=0.013). Thus, we found a model of partial mediation (Fig.4).
We established a partial mediation of the relationship between PTSD and aggressiveness by poor sleep quality. The direct effect accounts for 47.6% of the mediation, and the indirect effect through sleep disturbances accounts for 52.4%, which confirms the role of poor sleep quality as a mediator in this model.

**Discussion**

PTSD is a widespread mental disorder occurring in combatants during the first two years after a traumatic event, affecting 9-35% of them. War-related PTSD is more difficult to treat and can lead to more severe functional consequences [2].

PTSD in combatants is associated with health-related behaviors, including aggression, even at a subclinical level. Along with this, a frequent complaint among combatants is poor sleep quality. Recent studies underscore the causal role of sleep disorders in the onset of PTSD and related symptoms, since treating them improves PTSD outcomes, but sleep disorders often persist after PTSD treatment. Thus, sleep disturbances may mediate the clinical course of PTSD and related behaviors [14].

Our study found higher levels of aggression in combatants with PTSD, including higher hostility and physical aggression. Similar results were obtained in the analysis of Iraq and Afghanistan War veterans, who showed higher levels of anger and hostility in PTSD [8]. At the same time, our study examined only combatants whose levels of aggression would be expected to be higher than those of non-combatants as a result of combat service, according to other studies [7]. This may explain the absence of differences between our groups in the anger and verbal aggression pathways.

The prevalence of poor sleep quality in combatants with PTSD in our study exceeded 90%, which is consistent with well-known data that 70-91% of patients with PTSD have some sort of sleep disorder [12]. This relationship is bidirectional and is caused by many biopsychosocial factors, including problems with emotion regulation, immune dysregulation, and oxidative stress [17, 1].

Several meta-analyses have shown a link between sleep disturbance and aggression, in particular, short duration and poor quality of sleep are considered to be the most significant [4, 18, 19]. In our study, poor sleep was associated with hostility, physical aggression, and general aggression, which may be due to the complex interplay between brain metabolic activity, hormonal changes, and behavior [22].

We found that poor sleep quality may act as a mediator in the relationship between PTSD and aggression. Previous studies have demonstrated that sleep and physical pain can moderate the PTSD-aggression association. Poor sleep increased the strength of the PTSD-physical aggression link [11], whereas our study found that poor sleep quality fully mediated the relationship between PTSD and hostility.

**Conclusions**

Our findings emphasize that sleep disturbance is a significant symptom of PTSD that can affect other aspects of the disease in combatants. In this study, we demonstrated that poor sleep quality mediates hostility and general aggression in combatants with PTSD. The significant prevalence of sleep disorders among combatants with PTSD, particularly those exhibiting increased aggression, underscores the need for addressing sleep disturbances in
PTSD treatment protocols. At the same time, given the mediating role of sleep in the relationship between PTSD and aggression, it is reasonable to integrate a standardized assessment of sleep quality into both preventive and clinical care for combatants.

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Hitesh Chopra – C SEF

A – conception and design of the study; B – data collection; C – data analysis and interpretation; D – writing the article; E – revising the article; F – final approval of the article

**Conflict of interest:**

The authors declare that they have no conflict of interest.

**Ethical statement:**

This research was approved by the Commission on Biomedical Ethics of Poltava State Medical University (minutes No.222; as of 21 December 2023).

**References**


ПОСЕРЕДНИЦЬКА РОЛЬ ПОГАНОЇ ЯКОСТІ СНУ У ВЗАЄМОЗВ’ЯЗКУ МІЖ ПОСТТРАВМАТИЧНИМ СТРЕСОВИМ РОЗЛАДОМ ТА АГРЕСІЄЮ У КОМБАТАНТІВ.

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Вступ. Психічні розлади, пов’язані зі стресом, становлять значний ризик для соціального, емоційного та фізичного благополуччя пацієнта. Однією з найбільш вразливих категорій населення до розвитку пов’язаних зі стресом психічних розладів, зокрема посттравматичного стресового розладу, у воєнний час є військовослужбовці, які постійно стикаються з подіями, що загрожують їхньому життю і здоров’ю. Найпоширенішими скаргами комбатантів з посттравматичним стресовим розладом є порушення сну та агресія. Тому ми припустили, що погана якість сну може опосередковувати зв’язок між посттравматичним стресовим розладом та агресією у комбатантів.

Матеріали та методи. Ми провели клінічне дослідження 45 комбатантів, які були розподілені на такі групи: група 1 (n=24) – комбатанти з ПТСР, і група 2 (n=21) – комбатанти без психічних розладів, пов’язаних зі стресом. Ми вимірювали якість сну за Піттсбурзьким індексом якості сну та агресію за опитувальником агресії Басса-Перрі. Статистичний аналіз проводили за допомогою програми Jamovi Desktop. Аналіз посередництва проводився за допомогою модулів medmod 1.1.0 та advanced mediation models 1.0.5.

Результати. Ми виявили сильний статистично значущий вплив ПТСР на фізичну агресію (p<0,001). Однак не було виявлено опосередковуючої ролі поганої якості сну (p=0,264), оскільки вплив порушення сну на фізичну агресію не підтвердився (p=0,257), незважаючи на сильний вплив ПТСР на порушення сну (p<0,001). Було виявлено повний ефект посередництва поганою якістю сну зв’язку між ПТСР і ворожістю, який становив 74,1% медіації. Встановлено часткове опосередкування зв’язку між ПТСР та агресивністю через погану якість сну. На прямий вплив припадає 47,6% медіації, а на опосередкований вплив через порушення сну - 52,4%, що підтверджує роль поганої якості сну як медіатора в цій моделі.

Висновки. Наші результати підкреслюють, що порушення сну є важливим симптомом ПТСР, який може впливати на інші аспекти захворювання у комбатантів. У цьому дослідженні ми продемонстрували, що погана якість сну повністю опосередковує ворожість і частково загальну агресію у комбатантів з ПТСР.

Ключові слова: порушення сну, посттравматичний стресовий розлад, агресія, комбатанти, аналіз посередництва.