

Research Article

Sleep and Mood as Mechanisms Linking Trauma Exposure to Alcohol Use in South African First Responders: A Serial Mediation AnalysisTyrone Pretorius ^{†, *}, Anita Padmanabhanunni [†]

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Academic Editor: Deborah Suchecki

OBM Neurobiology

2025, volume 9, issue 4

doi:10.21926/obm.neurobiol.2504308

Received: June 15, 2025

Accepted: November 10, 2025

Published: November 14, 2025

Abstract

First responders are routinely exposed to traumatic events in the line of duty, placing them at heightened risk for adverse mental health outcomes, including substance use. This study investigated the psychological mechanisms linking trauma exposure to alcohol use, specifically examining the serial mediating roles of insomnia and depression. A sample of 429 first responders (309 police officers and 120 paramedics) from the Western Cape, South Africa, completed an online survey comprising the Life Events Checklist-5, Insomnia Severity Index, Patient Health Questionnaire-9, and the Alcohol Use Disorders Identification Test. Mediation analysis was conducted using the Hayes PROCESS macro (Model 6) in SPSS. Trauma exposure was significantly associated with increased levels of insomnia, depressive symptoms, and alcohol use. Mediation analysis revealed that both insomnia and depression independently fully mediated the relationship between trauma exposure and alcohol use. Additionally, a significant serial mediation pathway was observed, indicating that trauma exposure led to insomnia, which in turn contributed to depression, ultimately resulting in higher alcohol use. These findings highlight the central role of sleep disturbances and depressive symptoms in the trauma–alcohol use nexus among first responders. Interventions that address insomnia may



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not only alleviate depressive symptoms but also serve to mitigate harmful alcohol use in this high-risk population.

Keywords

First responders; trauma exposure; insomnia; depression; alcohol use; serial mediation; South Africa

1. Introduction

First responders provide critical emergency services to promote public health and safety. This population group includes police, paramedics, firefighters, and emergency call operators. Due to the stressful nature of their work and consistent exposure to potentially traumatic events, first responders are particularly at risk for developing specific types of conditions. In comparison to the general population, they experience higher levels of post-traumatic stress disorder (PTSD), mood disorders (e.g., major depressive disorder), sleep disturbances, anxiety and alcohol and substance related disorders [1].

First responders are frequently exposed to potentially traumatic events in the course of their work, and this enhances their risk of developing PTSD. Existing studies suggest that there is a dose-response relationship in that those with greater levels of trauma exposure are likely to experience greater psychological impairment [2]. Hazardous and harmful alcohol use also occurs at higher rates among first responders [3-5]. While dangerous alcohol use is defined as a pattern or quantity of alcohol consumption that increases risk of adverse health outcomes, harmful alcohol use refers to alcohol consumption that leads to more immediate adverse consequences [6]. The self-medication hypothesis is an empirically established theoretical framework for explaining the associations between trauma exposure and alcohol use. It proposes that alcohol use is reflective of either avoidant-coping (e.g., drinking to diminish strong negative emotions) or enhancement-related reasons (e.g., drinking to enhance positive mood and diminish emotional numbing) [7].

For first responders, alcohol use frequently co-occurs with trauma exposure and may represent a maladaptive coping strategy to chronic occupational stress. Due to the nature of their work, which routinely involves responding to critical incidents such as accidents, violence, and death, first responders face an elevated risk of developing PTSD. This risk is compounded by the cumulative effect of repeated exposure to potentially traumatic events over time [3, 8]. In the context of PTSD, individuals may resort to alcohol use as a form of self-medication to alleviate distressing psychological symptoms. These symptoms include intrusive memories, flashbacks, nightmares, and heightened physiological arousal, such as irritability, sleep disturbances, and an exaggerated startle response [4]. Alcohol may be used to blunt the intensity of these symptoms temporarily or to induce a sense of emotional detachment and relaxation. However, this coping strategy can lead to a harmful cycle, wherein the short-term relief provided by alcohol reinforces continued use, ultimately increasing the likelihood of developing an alcohol use disorder. Moreover, alcohol use can interfere with recovery by impairing emotional processing, reducing adherence to treatment, and intensifying PTSD symptoms in the long term [5, 9]. The co-occurrence of trauma exposure and alcohol use among first responders suggests the presence of mediating variables. The present study

sought to expand on the research in this area by investigating the psychological mechanisms linking trauma exposure to alcohol use, specifically examining the serial mediating roles of insomnia and depression.

Insomnia among first responders has been well documented as a significant concern [10, 11]. It involves difficulty initiating sleep, trouble maintaining sleep, or waking up earlier than desired [12]. Insomnia among trauma-exposed occupational groups has been attributed to the demanding and often unpredictable nature of their work involving irregular shifts, long hours, and overnight duties [10, 11]. These responsibilities can severely disrupt circadian rhythms and impair the ability to maintain consistent sleep schedules [13]. Furthermore, the high-stress environments in which first responders operate can lead to heightened physiological arousal, making it difficult to achieve restful sleep. Consistent exposure to trauma, critical incidents, and life-threatening situations can precipitate intrusive thoughts, hypervigilance, and heightened anxiety, all of which interfere with sleep initiation and maintenance [14]. Chronic insomnia can lead to increased fatigue, reduced cognitive functioning capacities, low mood, and impaired job performance.

Insomnia is also a symptom of depressive disorders, and existing studies among other population groups have highlighted the mediating role of insomnia and depression in the association between exposure to adverse events and alcohol use. For instance, insomnia has been found to partially mediate the relationship between childhood trauma exposure and severe mental health disorders in clinical samples [15]. Insomnia has also been reported to be a mechanism linking PTSD with increased alcohol use among veterans [16]. Depression has been reported to mediate the relationship between exposure to adverse childhood events and sleep disturbances among adolescents [17]. Research has also shown that depression partially mediates the relationship between exposure to potentially traumatic events and the development of PTSD in trauma-exposed occupational groups [18]. Existing evidence suggests a bidirectional relationship between trauma exposure, insomnia, depression, and alcohol use in which these conditions interact in mutually reinforcing ways that can intensify psychological distress and impair functioning, particularly among high-risk groups such as first responders [16].

The present study aimed to examine the relationship between trauma exposure and alcohol use among first responders, with a specific focus on the mediating roles of insomnia and depression. These two variables were selected as mediators in this study because they represent two of the most prevalent and impairing psychological conditions among trauma-exposed first responders. Both are closely tied to occupational stressors and trauma-related arousal, and they frequently co-occur with hazardous alcohol use. Based on prior research and theoretical frameworks linking trauma, sleep disturbance, mood, and alcohol use, the following hypotheses were formulated:

- Trauma exposure will be significantly positively associated with insomnia, depression, and alcohol use.
- Insomnia and depression will each independently mediate the relationship between trauma exposure and alcohol use.
- Trauma exposure will be indirectly associated with alcohol use through a sequential pathway involving insomnia and depression.

2. Materials and Methods

2.1 Participants and Procedure

Participants were first responders ($n = 429$) in the Western Cape province of South Africa, comprising 309 police officers and 120 paramedics. The Western Cape is characterized by high rates of community violence, frequent exposure to traumatic incidents, and substantial demands on emergency services, creating a particularly relevant context for investigating trauma-related outcomes among first responders [19].

The package “pwr” [20] in R software [21] was used to conduct a power analysis to determine whether the sample of 429 was sufficient for detecting mediation effects in a multiple regression framework. Cohen’s f^2 was used as the relevant effect size and refers to the amount of variance in the dependent variable explained by the mediators, over and above that described by the independent variable. Assuming a small-to-medium effect size ($f^2 = 0.05$), an alpha level of 0.05, and power set at 0.80, the minimum required sample was estimated at 222 participants. A post-hoc power analysis using the “pwr2ppl” package [22] in R was conducted to assess the actual power achieved based on the correlation coefficients obtained in the current study. The results indicated that power achieved was 0.883 for insomnia as the mediator, 0.879 for depression as the mediator, and 0.883 for the serial mediation.

An electronic version of the instruments described in the Measures section was constructed using Google Forms. The electronic form consisted of five screens: the first contained the informed consent statement, the second included demographic questions, and the remaining three contained the psychometric instruments. On average, the survey took approximately 25 minutes to complete. The form was configured to prevent multiple submissions from the same device, and all questions were set to mandatory, eliminating the possibility of missing responses. Thus, participants were required to complete all items before advancing to the next screen.

All instruments were administered in English. In South Africa, English is widely used as the primary medium of communication in professional, administrative, and training contexts for first responders, including police officers and paramedics. As such, it was not necessary to translate the instruments into other languages. No financial or material incentives were offered for participation. Participation was voluntary, and respondents could withdraw at any time before submitting the form without penalty.

Due to South Africa’s Protection of Personal Information Act, it was not possible to obtain databases of first responders for random sampling. Therefore, permission was obtained from the administrators of Facebook groups for first responders to post the electronic link and an invitation to participate in the study. Additionally, approval was obtained from the South African Police Services and the Western Cape Department of Health, enabling research assistants to recruit participants in person by visiting police stations and hospitals. The socio-demographic profile of the respondents is reported in Table 1 for police officers and paramedics separately.

Table 1 Socio-demographic profile of police officers and paramedics.

Variable	Category	Police Officers		Paramedics	
		n/ $\bar{X}$	%/ <i>SD</i>	n/ $\bar{X}$	%/ <i>SD</i>
Gender	Women	138	44.7%	55	45.8%
	Men	171	55.3%	65	54.2%
Area of residence	Urban	292	94.5%	104	86.7%
	Peri-urban	6	11.9%	5	4.2%
	Rural	11	3.6%	11	9.2%
Educational qualifications	Matric/Grade 12	184	59.5%	32	26.7%
	Post-matric diploma/certificate	96	31.1%	49	40.8%
	Undergraduate degree	12	3.9%	29	24.2%
	Postgraduate degree	17	5.5%	10	8.3%
Relationship status	Single	144	46.7%	64	53.3%
	Married	165	53.4%	56	46.7%
Age		39.41	10.06	37.94	9.52
Length of service		13.5	9.5	12.53	10.03

Overall, slightly more than half of the respondents were men (55%), and the majority resided in urban areas (92.3%). The sample was almost equally divided between married (51.5%) and single (48.5%). Regarding educational qualifications, nearly half of the participants had obtained a matric certificate (Grade 12; 49.2%), while 49.7% reported having a post-matric qualification. The mean age of the participants was 39 years ($SD = 9.93$), and the mean duration of service as a first responder was 13.24 years ($SD = 9.65$).

2.2 Measures

Participants completed the following standardized research questionnaires: the Life Events Checklist-5 (LEC-5) [23] the Insomnia Severity Index (ISI) [24] the Patient Health Questionnaire-9 (PHQ-9) [25] and the Alcohol Use Disorders Identification Test (AUDIT) [26] A brief demographic questionnaire was also administered.

The LEC-5 consists of 17 items assessing past exposure to traumatic events (e.g., natural disasters, transportation accidents) using a 6-point scale based on the proximity of the event to the individual, with events directly experienced scored as 5 and events not applicable scored as 0. Following the recommendation of Weis and colleagues [27], responses were weighted such that greater scores reflected greater proximity and frequency of exposure: events directly experienced were weighted by a factor of 3, events witnessed by a factor of 2, and events learned about by a factor of 1. Weis and colleagues reported reliability coefficients of 0.83 and 0.87 for the weighted scoring version of the LEC-5 [27]. A South African study reported an internal consistency estimate of 0.76 for LEC-5 scores in a sample of counsellors [28].

The ISI is a 7-item measure assessing the nature and severity of sleep problems associated with insomnia. Items are rated on a 5-point scale, with higher scores indicating greater sleep difficulties. An example item is, "How worried/distressed are you about your current sleep problem?" The authors of the ISI reported a reliability coefficient of 0.74 [24]. No studies were identified that reported on the psychometric properties of the ISI in South African samples.

The PHQ-9 is a 9-item instrument designed to screen for, monitor, and measure the severity of depression. Items are rated on a 4-point scale ranging from 0 (*not at all*) to 3 (*nearly every day*). An example item is, "Over the last two weeks, how often have you been bothered by little interest or pleasure in doing things?" The PHQ-9 validation study reported reliability coefficients of 0.86 and 0.89 across two samples [25]. The PHQ-9 has also been widely used in South African studies [29-31], with reported reliability coefficients generally exceeding 0.75.

The AUDIT is a 10-item measure developed to screen for risky or harmful alcohol use. Items are scored on a 5-point scale (0–4), with higher scores indicating greater risk. An example item is, "During the past year, how often have you had a feeling of guilt or remorse after drinking?" The AUDIT has demonstrated reliability coefficients ranging from 0.80 to 0.98 across six countries [26]. Several studies in South Africa have used the AUDIT [32, 33], reporting reliability coefficients generally above 0.75.

2.3 Ethics

The Humanities and Social Sciences Research Ethics Committee of the University of the Western Cape granted ethical approval for the study, (ethics reference: HS23/2/4, May 23, 2023). The study was conducted in accordance with the Declaration of Helsinki. Informed consent was provided on the landing page of the electronic questionnaire, and participants were informed that they could withdraw at any time during the questionnaire.

2.4 Data Analysis

All analyses were conducted using IBM SPSS for Windows, version 30 (IBM Corp., Armonk, NY, USA). Descriptive statistics (means and standard deviations), distribution indices (skewness and kurtosis), intercorrelations between study variables (Pearson's r), and estimates of internal consistency (Cronbach's α and McDonald's ω) were calculated.

Mediation analysis was conducted using the Hayes PROCESS macro (Model 6) [34] for SPSS. In this analysis, exposure to trauma served as the independent variable, alcohol use as the dependent variable, and insomnia and depression as sequential mediators. The significance of the indirect (mediation) effects was evaluated using bootstrapped 95% confidence intervals. The mediation models were specified and tested in line with established theoretical frameworks linking trauma exposure, sleep disturbance, depression, and alcohol use.

To control for the potential confounding effects of demographic variables, we examined the relationship between demographic variables and the dependent variable (alcohol use) using t -tests to examine group differences (gender, type of first responder, educational qualifications, and relationship status), and correlational analysis for continuous variables (age and length of service). When group differences or correlations were significant, these variables were added to the mediation analysis as covariates.

3. Results

Descriptive statistics, distribution indices (skewness and kurtosis), intercorrelations among study variables, and reliability estimates (α and ω) are presented in Table 2.

Table 2 Intercorrelations, descriptive statistics, distribution indices, and reliabilities of scores.

Variables/Scales	1	2	3	4
1. Trauma exposure	—			
2. Insomnia	0.15*	—		
3. Depression	0.21**	0.52**	—	
4. Alcohol use	0.13*	0.30**	0.30**	—
Mean	23.79	10.89	9.51	8.87
SD	9.33	5.79	6.42	10.01
Skewness	-0.58	0.18	0.37	1.14
Kurtosis	0.49	-0.72	-0.49	0.60
Alpha	0.88	0.87	0.89	0.94
Omega	0.88	0.87	0.89	0.94

* $p < 0.01$, ** $p < 0.001$.

The distribution indices confirmed that all variables were approximately normally distributed, with skewness and kurtosis values ranging between -0.72 and 1.14. Internal consistency estimates (alpha and omega) ranged from 0.87 to 0.94, indicating that all measures produced reliable scores.

As shown in Table 2, trauma exposure was significantly positively correlated with insomnia ($r = 0.15$, $p = 0.002$; small effect size), depression ($r = 0.21$, $p < 0.001$; small effect size), and alcohol use ($r = 0.13$, $p = 0.007$; small effect size). Thus, higher trauma exposure was associated with higher levels of insomnia, depression, and alcohol use.

There was also a strong positive correlation between the two mediators, insomnia and depression ($r = 0.52$, $p < 0.001$; large effect size). Alcohol use was significantly positively correlated with both insomnia ($r = 0.30$, $p < 0.001$; medium effect size) and depression ($r = 0.30$, $p < 0.001$; medium effect size).

The results of two sample t-tests indicated significant differences between men ($\bar{X} = 24.44$, $SD = 9.12$) and women ($\bar{X} = 22.98$, $SD = 9.55$, $t = 4.05$, $p < 0.001$), as well as between police officers ($\bar{X} = 23.06$, $SD = 10.02$) and paramedics ($\bar{X} = 25.67$, $SD = 6.94$, $t = 5.39$, $p < 0.001$). There were no statistically significant differences between those who had obtained a school leaving certificate (matric) and those with post-matric qualification ($t = 0.82$, $p = 0.41$), as well as between those who were single and those who were married ($t = 0.41$, $p = 0.68$). Correlational analysis also indicated that alcohol use was not significantly associated with either age ($r = -0.07$, $p = 0.14$) or length of service ($r = -0.09$, $p = 0.06$). Gender and type of first responder were thus added to the mediation analysis as covariates.

The results of the mediation analysis are reported in Table 3.

Table 3 Results of the parallel and serial mediation analysis.

Effect	B	SE	95% CI		β	p-value
			LL	UL		
<u>Direct effects</u>						
Trauma exposure → Alcohol use	0.09	0.05	-0.00	0.18	0.08	0.06
Insomnia → Alcohol use	0.45	0.09	0.28	0.63	0.26	<0.001
Depression → Alcohol use	0.20	0.08	0.05	0.36	0.13	0.01
<u>Parallel mediating effects</u>						
Trauma exposure → Insomnia → Alcohol use	0.04	0.02	0.01	0.08	0.04	—
Trauma exposure → Depression → Alcohol use	0.02	0.01	0.00	0.04	0.02	—
<u>Serial mediating effect</u>						
Trauma exposure → Insomnia → Depression → Alcohol use	0.01	0.01	0.00	0.03	0.01	—

The results presented in Table 3 show that:

- Insomnia fully mediated the relationship between trauma exposure and alcohol use ($\beta = 0.04$, 95% CI [0.01, 0.08]). In the presence of insomnia as a mediator, the direct relationship between trauma exposure and alcohol use became nonsignificant ($\beta = 0.08$, $p = 0.06$). A separate regression analysis confirmed that when considered independently, trauma exposure was significantly associated with alcohol use ($\beta = 0.13$, $p = 0.007$).
- Depression also fully mediated the relationship between trauma exposure and alcohol use ($\beta = 0.02$, 95% CI [0.01, 0.05]). In the presence of depression as a mediator, the direct relationship between trauma exposure and alcohol use was nonsignificant.
- A serial mediation effect was observed, where trauma exposure influenced alcohol use through a sequential pathway involving insomnia and depression. The indirect effect through insomnia and then depression was significant ($\beta = 0.01$, 95% CI [0.00, 0.03]).

The serial mediation of insomnia and depression in the relationship between trauma exposure and alcohol use is visually presented in Figure 1.

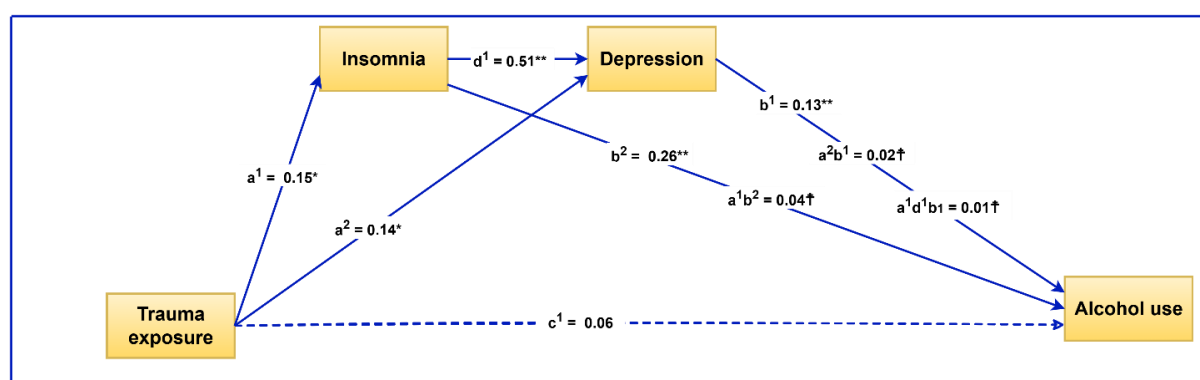


Figure 1 The serial mediating role of insomnia and depression in the relationship between exposure to trauma and alcohol use. **Note:** c^1 = direct effects of trauma exposure on alcohol use; $a^1 - a^2$ = direct effects of predictor on mediators; d^1 = direct effect of mediator1 on mediator2; $b^1 - b^2$ = direct effects of mediators on dependent variable; a^1b^2 indirect effects of predictor on dependent variable through insomnia a^2b^1

= indirect effects of predictor on dependent variable through depression; $a^1d^1b^1$ = indirect effect of predictor on dependent variable through insomnia and depression in sequence. Dotted line = non-significant direct effects, indicating full mediation. All regression coefficients are standardized. * $p < 0.01$, ** $p < 0.001$, † 95% confidence intervals.

In summary, the findings indicated that trauma exposure was significantly associated with higher levels of insomnia, depression, and alcohol use among first responders. Both insomnia and depression fully mediated the relationship between trauma exposure and alcohol use, individually and sequentially, suggesting that sleep disturbances and depressive symptoms are key mechanisms through which trauma exposure influences alcohol-related outcomes in this population.

4. Discussion

First responders are at increased risk of psychological distress due to the nature of their occupational roles, which involve frequent and prolonged exposure to potentially traumatic events. The cumulative impact of witnessing death, injury, and human suffering, coupled with the responsibility of making rapid decisions under pressure, places them at heightened risk for a range of adverse mental health outcomes [3, 6]. Existing studies have highlighted the co-occurrence of trauma exposure and alcohol use among trauma-exposed population groups, suggesting the presence of mediating variables [6, 15]. Specifically, while trauma exposure is a well-established risk factor for hazardous drinking, not all individuals exposed to trauma develop problematic alcohol use. This points to the involvement of intermediary processes. Prior literature highlights two particular pathways: trauma-related sleep disturbance (e.g., hyperarousal, insomnia, and intrusive thoughts) and trauma-related affective disturbance (e.g., low mood). Both insomnia and depression may therefore function as mechanisms that mediate the relationship between trauma exposure and alcohol use, helping to explain the variability in drinking behaviors among first responders [6, 15, 16].

The present study sought to contribute to the literature base by investigating the psychological mechanisms linking trauma exposure to alcohol use, specifically examining the serial mediating roles of insomnia and depression. There were several salient findings.

First, trauma exposure was significantly associated with increased levels of insomnia, depression, and alcohol use. Individuals with higher levels of trauma exposure tended to report more severe sleep disturbances, greater depressive symptoms, and higher levels of alcohol consumption. This supports a dose-response relationship, wherein the severity or frequency of exposure to potentially traumatic events is proportionally linked to the intensity of psychological distress and maladaptive coping behaviors [35, 36]. The dose-response model suggests that repeated or more intense exposure to trauma overwhelms an individual's coping capacity, thereby increasing the likelihood of adverse mental health outcomes [36]. This finding is supported by studies undertaken among other categories of first responders, including firefighters [37, 38] and military veterans [16]. For instance, Zegel and colleagues found that trauma exposure and PTSD symptoms were positively associated with depression, sleep disturbances, and alcohol use among firefighters [38]. Huang and colleagues reported similar results in a meta-analytic study of first responders for medical emergencies [39].

Second, the study confirmed that alcohol use was significantly positively correlated with both insomnia and depression, indicating that higher levels of alcohol consumption were associated with greater sleep disturbances and more severe depressive symptoms. This suggests that first responders may be using alcohol as a means to cope with sleep difficulties. However, while alcohol may offer short-term relief, it can lead to more fragmented and less restorative sleep over time. This creates a vicious cycle in which alcohol use both stems from and exacerbates insomnia. Similarly, the positive association between alcohol use, insomnia, and depression reflects a well-documented bidirectional relationship [40, 41]. For instance, Brockdorf and colleagues reported that women with a history of trauma used alcohol to cope with the emotional consequences of poor sleep, thereby reinforcing a problematic cycle of distress and drinking [42]. Similarly, a general population study found that hazardous drinking was related to insomnia through its effects on depression [43].

Depressive symptoms such as low mood, anhedonia, and feelings of hopelessness may increase vulnerability to alcohol misuse as individuals seek to self-medicate or numb emotional pain [44]. In turn, chronic alcohol use can worsen depressive symptoms by disrupting neurochemical balance, impairing judgment and problem-solving abilities, and contributing to social and occupational dysfunction.

Third, the findings indicate that both insomnia and depression served as full mediators in the relationship between trauma exposure and alcohol use. Specifically, when insomnia was included in the model as a mediating variable, the previously significant direct relationship between trauma exposure and alcohol use was no longer statistically significant. This suggests that the impact of trauma exposure on alcohol consumption operates primarily through its effect on sleep disturbances. Individuals exposed to higher levels of trauma may experience elevated arousal, intrusive thoughts, and sleep disruption, which in turn may lead to increased alcohol use as a maladaptive strategy to manage insomnia. Similarly, depression was also found to mediate the relationship between trauma exposure and alcohol use. Individuals experiencing trauma-related distress may develop symptoms such as low mood, hopelessness, and emotional numbness, which in turn may prompt the use of alcohol as a means of emotional regulation or escape [7, 44]. Significantly, when trauma exposure was examined independently, it was associated with alcohol use. This highlights the critical role that both insomnia and depression play in explaining the pathway from trauma to alcohol use.

Given the well-established bidirectional relationship between insomnia and depression, the serial pathway should be interpreted with caution. While the present study tested this directional ordering, the analyses cannot establish temporal precedence. Thus, the significant indirect effects observed here may reflect overlapping and mutually reinforcing processes rather than a strictly linear sequence. The direction specified in the model was informed by theoretical accounts emphasizing the role of trauma-related arousal and sleep disturbance as precursors to depressive symptomatology [15, 17].

Finally, a serial mediation effect was observed in which trauma exposure influenced alcohol use through a sequential pathway involving both insomnia and depression. This finding suggests that the impact of trauma on alcohol use is not only mediated by these factors individually but also through a cumulative process in which one psychological consequence leads to another, ultimately increasing vulnerability to alcohol use. Individuals who experience high levels of trauma often report significant disruptions in sleep, including difficulty falling or staying asleep, nightmares, and restless sleep [16]. These sleep disturbances can, in turn, have a detrimental impact on mood and emotional

regulation. Persistent insomnia is a known risk factor for the development of depressive symptoms, as inadequate and poor-quality sleep interferes with the brain's ability to manage stress, process emotions, and maintain psychological resilience [45]. As depression sets in, individuals may increasingly turn to alcohol as a form of self-medication to cope with the emotional and physiological symptoms of both insomnia and depression [46].

The findings of this study have implications for intervention and underscore the need for integrated, holistic interventions to support the mental health of trauma-exposed occupational groups. Insomnia emerged as a critical mechanism in the pathway from trauma to alcohol use, both independently and as a precursor to depression. This underscores the importance of early identification and treatment of sleep disturbances in trauma-exposed populations. Interventions such as cognitive-behavioral therapy for insomnia (CBT-I) have demonstrated strong efficacy. They could serve as a key preventive measure to disrupt the trajectory from trauma exposure to more entrenched psychological and behavioral problems [47, 48]. By improving sleep quality, individuals may experience better emotional regulation and reduced vulnerability to depressive symptoms and alcohol misuse. Furthermore, the findings emphasize the value of integrated treatment models that address co-occurring symptoms in a coordinated manner. Transdiagnostic approaches, such as acceptance and commitment therapy (ACT) or trauma-focused cognitive-behavioral therapies, can be adapted to include modules on sleep hygiene, emotion regulation, and alcohol use management [49, 50]. These approaches are particularly relevant in high-risk occupational settings, where stigma and time constraints may impede access to mental-health care [50].

This study has several limitations that should be considered when interpreting the findings. The data were collected using self-report measures, which are subject to potential biases such as social desirability, recall inaccuracies, and underreporting, particularly in relation to sensitive topics like alcohol use and mental health symptoms. The reliance on self-report may have influenced the accuracy of symptom endorsement and the relationships observed among variables. The sample was limited to police officers and paramedics from a single geographical area within South Africa. While these groups represent key categories of first responders, the findings may not generalize to other first responder populations or those working in different regions. The geographical specificity necessitates replication across broader, more diverse samples. Additionally, the cross-sectional nature of the study precludes any conclusions about causality. Although mediation analyses were conducted, these statistical models cannot establish temporal ordering or confirm that the mediators developed as a result of trauma exposure. Longitudinal research is needed to validate the directionality of the relationships and to understand better how symptoms unfold and interact over time. There may also be unmeasured confounding variables that influenced the observed associations. Factors such as prior mental health history, personality traits (e.g., neuroticism), social support, coping style, and organizational stressors could also contribute to the development of insomnia, depression, or alcohol use and were not accounted for in the present analysis. Future research should include a broader range of individual and contextual variables to more fully capture the complex pathways linking trauma exposure to adverse psychological outcomes. A final limitation concerns the heterogeneity within the first-responder population. Our sample comprised both police officers and paramedics, whose occupational roles, shift schedules, and exposure to trauma differ substantially. These differences may shape the pathways linking trauma exposure, insomnia, depression, and alcohol use in distinctive ways. Future research would benefit from

disaggregating these subgroups to provide more nuanced information regarding profession-specific risk factors.

5. Conclusions

Existing research has shown that first responders face an elevated risk of adverse mental health outcomes due to their consistent exposure to potentially traumatic events in the course of their occupational duties [51]. The current study provides further evidence for both direct and indirect pathways linking trauma to alcohol use, with insomnia and depression serving as key mediators. Notably, the serial mediation effect highlights how sleep disturbances may contribute to the development of depressive symptoms, which in turn increase the risk of alcohol misuse. These insights reinforce the need for comprehensive, integrative mental health interventions that address the full spectrum of trauma-related outcomes, rather than focusing on individual symptoms in isolation. Given the demanding and high-risk nature of first responder work, early identification and treatment of sleep and mood disturbances may be critical in mitigating the long-term psychological impact of trauma exposure.

Author Contributions

AP and TP contributed equally to the conceptualization and data collection. TP was responsible for the data analysis. All authors contributed equally to the writing, review, and editing of this article.

Competing Interests

The authors have declared that no competing interests exist.

Data Availability Statement

The data sets generated and/or analyzed during the current study are available from the corresponding author (TP) upon reasonable request.

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