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ORIGINAL ARTICLE

Structural Equation Model of Stress, Anxiety, and Depression Association with Musculoskeletal Disorders among Emergency Medical Personnel

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ABSTRACT

Background: Emergency medical personnel play a crucial role in saving the lives of patients and injured individuals before they receive hospital services. Given their working conditions and environment, emergency medical service personnel are at risk for mental health issues and musculoskeletal disorders. Therefore, this study aimed to investigate the relationship between stress, anxiety, and depression with musculoskeletal disorders among emergency medical personnel in Qom Province.

Methods: This descriptive-analytical cross-sectional study was conducted among 177 emergency medical service personnel in Qom city, selected through simple random sampling. Data collection tools included demographic questionnaires, the Depression Anxiety Stress Scales (DASS), and a body map chart. Data analysis was performed using descriptive statistical tests and multivariate structural equation modeling techniques, as well as Cronbach's alpha coefficients and average variance extracted (AVE) analysis, with the help of SPSS version 22 and AMOS version 20 software.

Results: The average age of the participants was 33.03 ± 7.48 years. Most participants (84%) reported symptoms of musculoskeletal disorders. The reliability and validity of the DASS questionnaire and its subscales were confirmed with acceptable Cronbach's alpha coefficients (0.7) and average variance extracted (AVE) values (0.4). Levels of stress, anxiety, and depression were above average. No significant relationship was found between stress, anxiety, and depression and musculoskeletal disorders, and demographic variables did not moderate the relationship between these psychological factors and musculoskeletal disorders.

Conclusion: Given the high prevalence of musculoskeletal disorders and the elevated levels of stress, anxiety, and depression among emergency medical personnel—with no significant relationship found between these variables—it is essential to identify other influencing factors in this field. Implementing control measures to improve working conditions and the work environment is critical, especially considering the vital role of emergency medical personnel in the healthcare sector.

KEYWORDS: *Stress, Anxiety, Depression, Emergency Medical services, Musculoskeletal disorders.*

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INTRODUCTION

Emergency Medical Services (EMS) is a vital component of the healthcare system [1]. EMS personnel play a critical role in public health and safety, acting as first responders who deliver out-of-hospital [2], critical emergency care [3], and pre-hospital services to critically ill or injured patients 24/7 [4]. Their work environment is inherently dynamic and unpredictable, spanning residential homes, highways, industrial facilities, prisons, offices, and public areas. They perform their duties regardless of time day or night—and under varying environmental conditions.

This unpredictability exposes EMS personnel to traumatic events [3], including severe and distressing situations such as caring for patients at risk of death [5], witnessing suffering, operating in hazardous environments [6], and encountering disfiguring wounds, devastating injuries, severe mental illness, childbirth, and cardiac arrest. The intense and often harrowing nature of these scenarios frequently contributes to the development of stress symptoms among emergency medical technicians (EMTs) [7].

Moreover, EMS personnel face additional occupational risks, such as contracting infectious diseases, shift work, extended working hours, and poor sleep quality [8]. These stressors are compounded by the high-pressure demands of performing complex tasks rapidly, often under emotional and physical strain [6, 9]. Such cumulative challenges significantly impact the mental and physical well-being of EMS professionals [3]. Consequently, EMS personnel are recognized as a high-risk group for mental health disorders [10] and are considered to hold one of the most stressful occupations in healthcare [6].

Stress is defined as an unpleasant emotional experience characterized by feelings of anxiety, frustration, anger, and tension, triggered by specific environmental factors [11]. When not effectively managed, stress can lead to various physical and psychological symptoms, including gastrointestinal issues, musculoskeletal pain, sleep disturbances, fatigue, unsafe behaviors, reduced job satisfaction, burnout, emotional disorders, and depersonalization [12]. Prolonged exposure to stress is also strongly linked to mental health conditions such as anxiety and depression [12, 13].

Depression characterized by feelings of sadness, hopelessness, withdrawal, and sleep disturbances often co-occurs with anxiety, which is marked by tension, worry, and discomfort. Bentley and colleagues highlighted the high prevalence of depression, anxiety, and stress among EMS personnel [3].

In addition to mental health challenges, EMS personnel face significant risks of musculoskeletal disorders (MSDs), which are common among healthcare professionals due to physically demanding tasks especially manual patient handling [9]. MSDs encompass a broad range of conditions affecting muscles, tendons, ligaments, joints, bones, peripheral nerves, and blood vessels. These disorders result in pain, discomfort, and impaired movement [14–16].

EMS personnel, due to the physical nature of their work such as lifting, bending, twisting, patient transfers, and performing cardiopulmonary resuscitation (CPR) [1, 17] are particularly susceptible to MSDs. These conditions commonly affect the lower back, neck, and shoulders, with high annual prevalence rates reported among ambulance officers and EMS technicians [18]. The economic impact of MSDs is significant, imposing substantial costs on healthcare systems globally. These costs arise from reduced productivity, increased disability, absenteeism, and compensation claims in both developed and developing nations [14]. The high physical demands and awkward postures associated with EMS tasks further exacerbate the risk of MSDs [1, 17].

Research suggests that psychosocial factors, in conjunction with individual and occupational factors, play a critical role in the development of MSDs and pain [16, 19]. For example, Ming Ng and colleagues identified depression and other psychosocial factors as significant predictors of MSDs among teachers [20]. Similarly, Ekpenyong et al. found that stress significantly increases the risk of developing musculoskeletal disorders [21]. Ghanbary et al. reported a direct relationship between anxiety, depression, and the prevalence of MSDs [22].

Given the consequences of psychological pressures and workload on the efficiency, performance, and mental health of EMS personnel, these issues warrant urgent attention. The repercussions include early retirement, loss of experienced staff, increased compensation claims, and a significant economic burden on society and healthcare systems. These challenges are further exacerbated by the rising frequency of disasters, persistent personnel shortages, and the demanding nature of EMS work.

Despite the significance of this issue, limited studies have examined the relationship between stress, anxiety, and depression and MSDs among EMS personnel in Iran. To address this gap, the present study was designed to investigate the relationship between stress, anxiety, and depression and musculoskeletal disorders among EMS personnel in Qom Province. By employing a structural equation modeling approach, this research aims to provide a comprehensive understanding of these interrelated factors and their implications for improving the health and operational efficiency of EMS staff.

MATERIALS AND METHODS

This descriptive-analytical cross-sectional study was conducted to examine the effects of stress, anxiety, depression, and demographic factors on musculoskeletal disorders, using structural equation modeling, among 177 EMS personnel in Qom Province in 2019. Data were collected using a random sampling method. After providing necessary explanations about the study's importance and ensuring full compliance with ethical guidelines, data were obtained through self-reporting. Participants completed demographic questionnaires, the standard 21-item Depression Anxiety Stress Scales (DASS-21), and a body map chart.

Inclusion criteria were participants in general health with at least one year of work experience. Exclusion criteria included the use of medications affecting stress, anxiety, or depression; neurological and psychological problems; muscular and joint diseases; deformities; and unwillingness to continue participation at any stage of the study.

Questionnaires

Demographic Questionnaire

The questionnaire collected demographic information from participants, including age, gender, education level, work experience, operational area, daily working hours, and the number of patient transport missions performed within a 24-hour period.

DASS-21 Questionnaire

The questionnaire consists of 21 items, grouped into three subscales of 7 questions each, to assess the states of stress, anxiety, and depression. Participants rated their symptoms related to these three variables over the past week on a 4-point Likert scale, ranging from 0 to 3, indicating "not at all," "mild," "moderate," and "severe," respectively [23]. The score for each subscale ranges from 0 to 21 [24], and the total DASS-21 score ranges from 0 to 63 [25], with higher scores indicating more severe levels of stress, anxiety, and depression.

Based on their scores, participants are categorized into normal, mild, moderate, severe, and extremely severe levels for each subscale: depression (0–4, 5–6, 7–10, 11–13, 14+), anxiety (0–3, 4–5, 6–7, 8–9, 10+), and stress (0–7, 8–9, 10–12, 13–16, 17+) [26]. The validity and reliability of this questionnaire have been confirmed in various countries [24, 27–29]. In Iran, the Persian version of DASS-21 was validated by Kakemam et al., showing acceptable Cronbach's alpha coefficients for anxiety (0.79), stress (0.91), and depression (0.93), as well as test-retest reliability results ranging from 0.740 to 0.881 ($P < 0.01$) for the total questionnaire and its three subscales [30].

Body Map Chart

The body map chart was used to record symptoms of musculoskeletal disorders in different body regions. Participants indicated the severity of pain and discomfort in affected body parts by selecting numbers from 0 to 4, representing "no pain," "mild," "moderate," "severe," and "maximum pain," respectively [31].

Descriptive data analysis was performed using statistical tests (mean, standard deviation, percentage) with SPSS version 22 software. To analyze and test the simultaneous correlations among the study variables, the structural equation modeling (SEM) technique was employed. This method assessed the fit and compatibility of the measurement and structural models with the sample data. It evaluated the measurement model's fit and the reliability of constructs by examining factor loadings, Cronbach's alpha coefficient, composite reliability coefficient, and average variance extracted (AVE), to confirm construct validity.

The convergent and divergent validity, as well as the reliability of the instruments, were also analyzed. Relationships among the key variables stress, anxiety, depression, and musculoskeletal disorders were examined using SEM with AMOS version 20 software.

RESULTS

The descriptive statistical results for demographic variables, total questionnaire scores, and subscale scores of the study participants are presented in Table 1. The results indicate that the majority of EMS personnel held an associate degree, worked primarily in urban areas, and reported pain in one or more regions of their musculoskeletal system.

Table 1. Demographic Characteristics and DASS Scores

Variables	Characteristics	Mean (SD) or Percentage
Age		33.03 ± 7.48
Work Experience		8.86 ± 7.21
Daily Working Hours		2.19 ± 9.12
Number of Daily Missions		3.93 ± 7.98
Depression Score		20.31 ± 7.20
Anxiety Score		20.19 ± 6.77
Stress Score		24.99 ± 8.42
Total DASS Score		65.69 ± 20.82
Musculoskeletal Disorders	Yes	84.7%
	No	15.3%
Education Level	Associate Degree	65.9%
	Bachelor's Degree	30.6%
	Master's Degree and above	3.5%
Area of Activity	Town	70.3%
	Road	29.7%

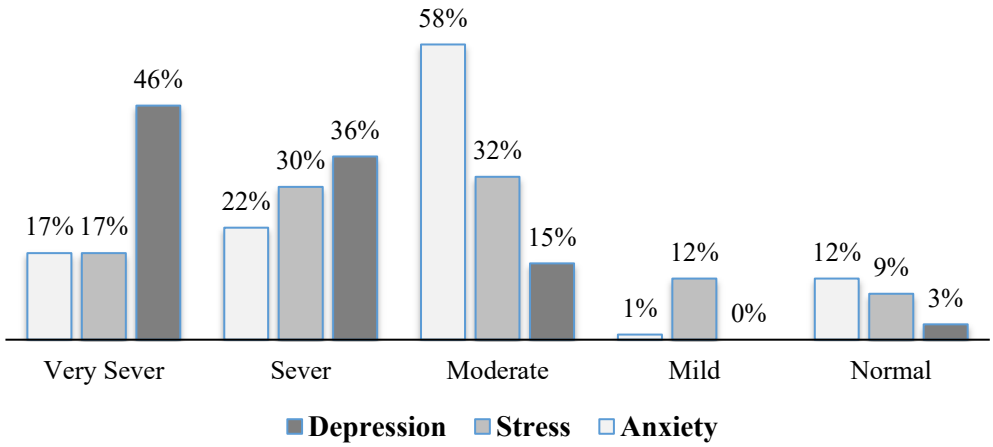

Figure 1. Percentage of anxiety, stress, and depression levels of participants on the DASS 21.

Table 2. The prevalence of MSDs in the last year (BM)

Body part		Frequency	%	Body part		Frequency	%
Neck		53	29.9	**Elbow**	R.	9	5.1
Shoulder	R.	34	19.2		L.	8	4.5
	L.	31	17.5	**Butt**	R.	12	6.8
Back	Upper	35	19.8		L.	12	6.8
	Lower	109	61.6	**Fingers**	R.	15	8.5
Arm	R.	8	4.5		L.	11	6.2
	L.	4	2.3	**Thighs**	R.	22	12.4
Leg	R.	26	14.7		L.	27	15.3
Wrist	R.	20	11.3	**Hand (Palm)**	R.	5	2.8
	L.	15	8.5		L.	4	2.3

The total score obtained from the DASS questionnaire was 65.69 ± 20.82. The percentages of individuals at each severity level of depression, anxiety, and stress are presented in Figure 1.

The findings revealed that 84.7% of individuals experienced pain in one or more regions of their musculoskeletal system at least once during the past year. The most commonly reported issue was lower back pain (61.6%), followed by neck pain (29.9%). The left hand and arm had the lowest prevalence, with only 2.3% of participants reporting related issues (Table 2).

The results of the convergent validity assessment, based on the Average Variance Extracted (AVE) criterion for the first-order variables and using the

Table 3. Cronbach's Alpha Coefficient, Composite Reliability, and Convergent Validity for the Overall Questionnaire and Subscales.

Variable	Average Variance Extracted (AVE)	Composite Reliability	Cronbach's Alpha Coefficient
Depression	0.68	0.71	0.80
Anxiety	0.48	0.67	0.82
Stress	0.40	0.82	0.83
Overall Questionnaire			1.00

Table 4. Square Root of AVE for Each Construct and Correlation Coefficients between Constructs.

Variables	Overall Questionnaire	Musculoskeletal Disorders	Depression	Anxiety	Stress
Overall Questionnaire	4.56				
Musculoskeletal Disorders	0.23	1.55			
Depression	0.90	0.14	0.91		
Anxiety	0.90	0.25	0.73	0.84	
Stress	0.93	0.23	0.60	0.69	0.80

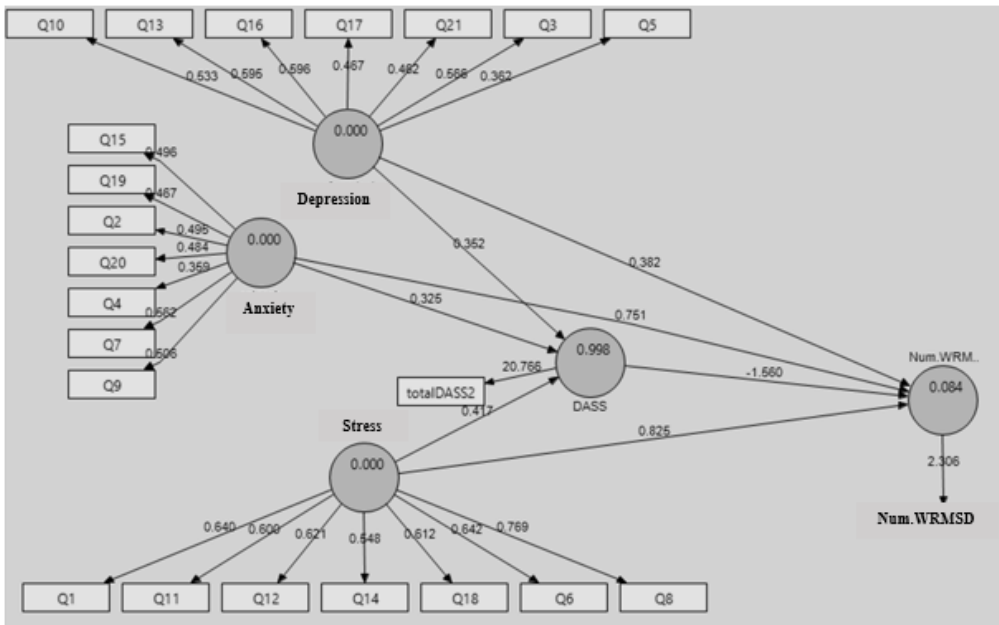

Figure 2. Factor Loadings of the DASS Questionnaire with Subscales and Musculoskeletal Disorders.

accepted threshold value of 0.4 [32], indicated that the questionnaire demonstrated acceptable convergent validity across the specified domains.

Additionally, the reliability of the questionnaire was evaluated using two criteria: Cronbach's alpha coefficient and the composite reliability coefficient. The findings showed that the Cronbach's alpha values for all items, and the composite reliability values for all items—except for the anxiety subscale, which showed a slight deviation—exceeded the minimum acceptable threshold of 0.7 (Table 3). These results confirm the internal consistency of the constructs [32].

The results of the discriminant validity analysis conducted by comparing the square root of the AVE for each construct with the correlation coefficients between constructs showed that each construct correlated more strongly with its own indicators than with those of other constructs. These findings confirm the acceptable discriminant validity of the questionnaires (Table 4).

In completing the evaluation of construct reliability along with reporting Cronbach's alpha coefficients and composite reliability factor loadings were also assessed. All factor loadings were found to be above 0.4, except for the relationship between the DASS questionnaire and musculoskeletal disorders, indicating the overall suitability of this criterion (Figure 2).

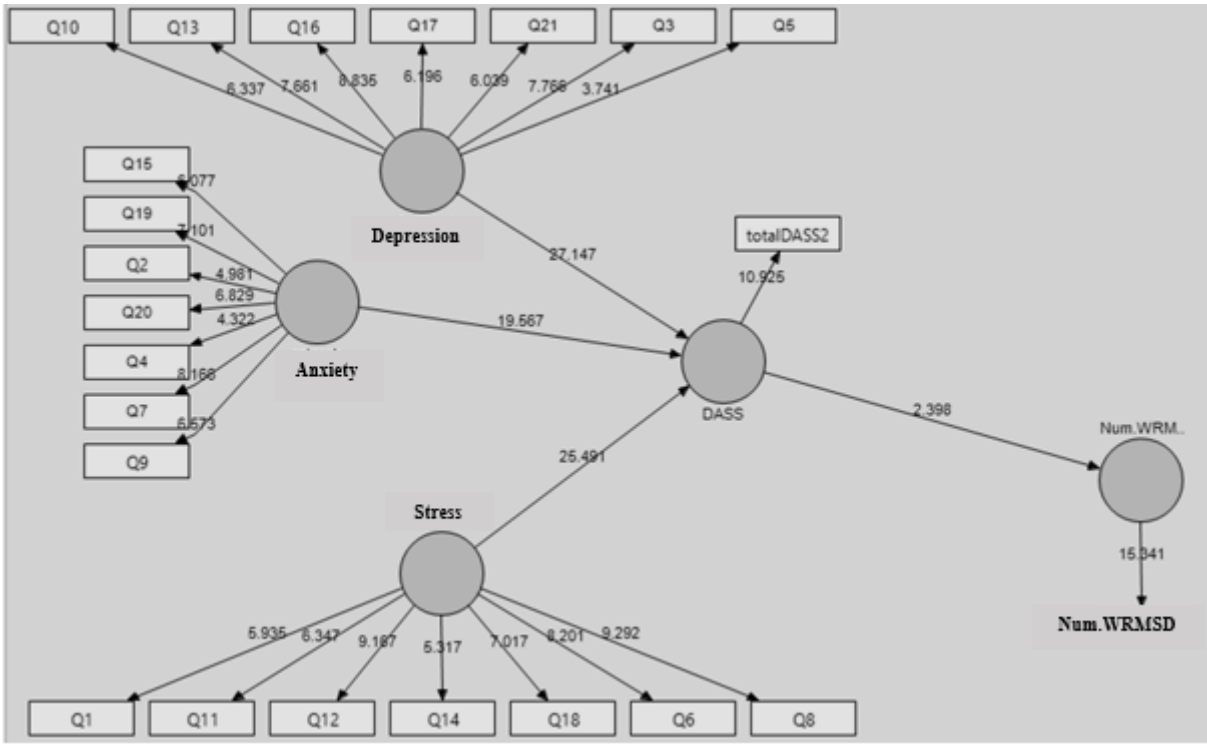

Figure 3. t-Values for the Significance of the Relationship between DASS and Subscales and Musculoskeletal Disorders.

Table 5. T-values and the impact of variables on each other.

Variable	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
DASS -> Num.WRMSD	-0.012	-0.076	0.8	0.015	0.988
Stress -> Num.WRMSD	0.22	0.253	0.335	0.657	0.511
Stress -> DASS	0.4	0.4	0.016	24.546	0.000
Anxiety -> Num.WRMSD	0.249	0.27	0.288	0.863	0.388
Anxiety -> DASS	0.334	0.334	0.014	24.23	0.000
Depression -> Num.WRMSD	-0.204	-0.187	0.307	0.664	0.507
Depression -> DASS	0.342	0.342	0.017	19.608	0.000

The results of the t-values used to test the hypothesized relationships are presented in Figure 3. A t-value greater than 1.96 indicates that the corresponding parameter is statistically significant, thereby confirming the research hypothesis regarding the relationships among the analyzed factors [33].

The standardized path coefficients calculated for the relationships between variables as shown in Table 5. According to the obtained results, the Goodness of Fit (GOF) value of 0.699, which is higher than the acceptable threshold of 0.4, indicates a good model fit.

$$GOF = \sqrt{Average(R^2) \times Average(Commundity)} = 0.699$$

Based on the obtained t-values, the results shown in Figure 4 reveal that the variables of depression, anxiety, and stress do not have a significant impact on musculoskeletal disorders.

The results show that the t-values for all moderator variables are less than 1.96, indicating that these variables do not have a significant moderating effect on the relationship between the DASS questionnaire and musculoskeletal disorders (Table 6).

DISCUSSION

This study aimed to model the structural relationships between stress, anxiety, depression, and demographic factors with the prevalence of musculoskeletal disorders (MSDs) among emergency medical personnel in Qom Province. The findings revealed an alarmingly high prevalence of MSDs (84.7%), consistent with studies conducted on emergency medical personnel [34–38] and other healthcare staff [14, 39]. The most commonly affected areas were the lower back, neck, and shoulders, aligning with findings from similar investigations [14, 35, 39–42].

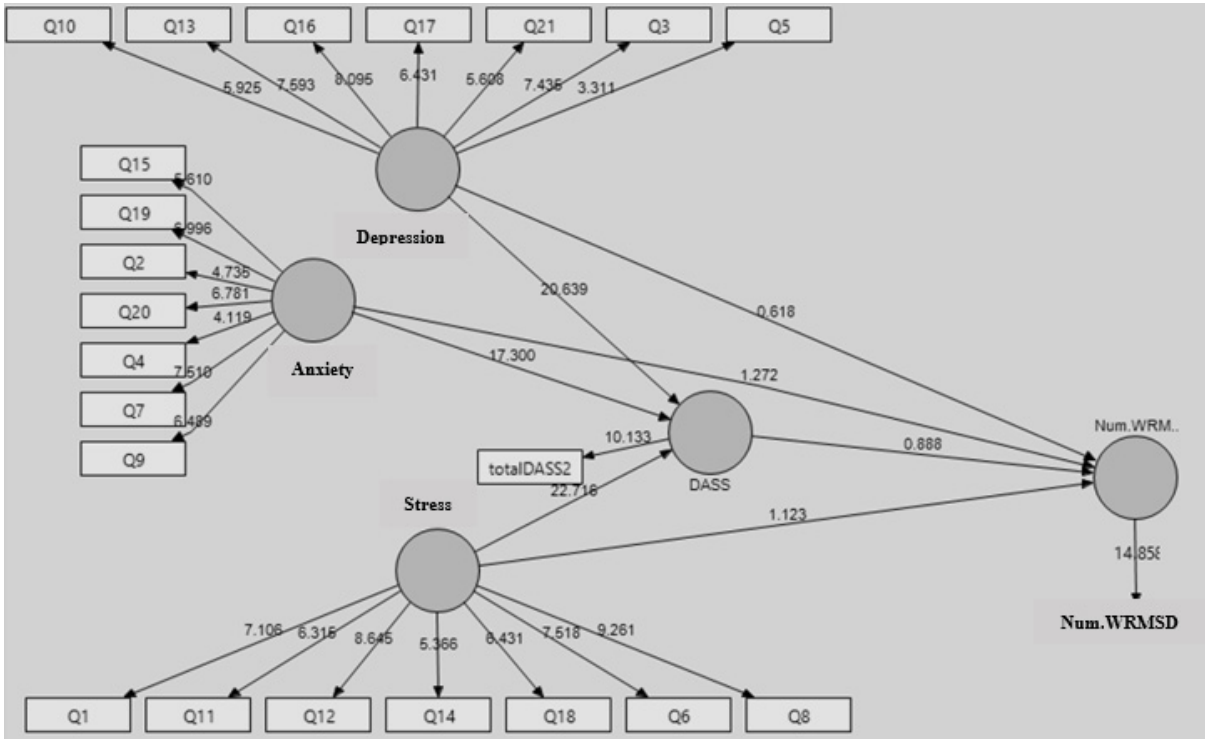

Figure 4. t-Values for the Significance of the Relationship between Stress, Anxiety, Depression, and Musculoskeletal Disorders

Table 6. Coefficients and t-Values for Moderator Variables in the Model.

Moderator Variable	Coefficient of Moderator Variable in the Model	Interaction Effect with DASS on Musculoskeletal Disorders	t-Value
Age	0.002	-0.106	0.281
Daily Work Hours	0.241	-0.0003	0.001
Work Experience	-0.120	0.033	0.107
Operational Area	-0.320	0.247	0.523
Number of Missions	-0.171	0.247	0.85
Education Level	0.435	-0.42	1.19

High prevalence rates can be attributed to a combination of physical, psychosocial, demographic, and organizational factors. Physical factors such as improper body posture, repetitive bending, and heavy lifting were prominent contributors. Psychosocial stressors including role conflict and low job satisfaction also played a critical role. Additionally, demographic factors (e.g., age, BMI) and organizational conditions (e.g., irregular shifts, staffing shortages) were significant influences [43, 44].

Psychological analysis using the DASS-21 questionnaire highlighted high levels of depression (severe and moderate), stress (severe and moderate), and anxiety (very severe and severe). These findings align with those of Cash et al., who reported high levels of stress among EMS personnel [8], while Soltaninejad et al. noted severe depression but lower levels of anxiety and stress [45]. The critical and high-pressure nature of emergency medical work which demands rapid decision-making and life-saving interventions likely amplifies these psychological stressors [41].

Reliability testing confirmed the robustness of the questionnaire. Cronbach's alpha coefficients exceeded 0.7 across all subscales, indicating high internal consistency [32]. Factor loadings above the 0.4 threshold further supported construct reliability [41]. Average Variance Extracted (AVE) values were satisfactory for depression (0.68), but borderline for anxiety (0.48) and stress (0.40). These findings are consistent with previous studies validating the Persian version of the DASS-21, including those conducted by Kakemam and Talwar [30, 47].

No significant relationships were found between moderating variables (age, daily working hours, work experience, operational field, mission count, and

education level) and psychological variables (stress, anxiety, and depression). Similar results were reported by Talaqani et al. in a study among nurses, which found no significant associations between demographic factors and psychological stressors [36]. However, other studies such as those by Nia RG and Sabbaghi identified significant correlations between variables like age, education, and employment status and psychological outcomes [50, 51]. These discrepancies may be attributed to differences in study populations or methodologies.

Additionally, no significant relationship was observed between the moderating variables and the prevalence of MSDs in this study. These findings are consistent with research by Choubineh et al., which identified only gender and work experience as influential factors [37], and by Stankevitz et al., who found no association between stress and MSD prevalence in men under the age of 55 [52]. Age-related physiological changes such as decreased muscle mass and strength may help explain the lack of significant correlations [43].

Finally, the study found no significant associations between stress, anxiety, depression, and MSDs. Similar results were reported by Borzideh et al. [53], Hendi et al. [54], and Azari et al. [55]. These outcomes suggest that physical factors such as improper posture and heavy lifting have a greater impact on the prevalence of MSDs. Regression models in related research frequently indicate that psychological variables have less explanatory power when physical workload factors are taken into account [37, 61]. Kerr et al. likewise emphasized the dominant role of physical strain in lower back disorders compared to psychological stressors [61].

LIMITATION

Due to its cross-sectional design, this study identifies associations between variables but does not establish causality regarding the incidence of stress, anxiety, depression, and demographic factors among emergency medical personnel. Additionally, because the data were collected through self-reported questionnaires, there is a potential for recall bias. Although the study included the entire population of EMS personnel in Qom Province, expanding the sample size could enhance the generalizability of the findings.

CONCLUSION

Based on the results obtained from this study and a review of similar articles, it is evident that emergency medical personnel are exposed to stress, anxiety, and depression. Identifying the factors causing stress and managing the work environment scientifically can help prevent psychological disorders and improve the mental health of personnel. Given the lack of significant relationship between psychological factors and musculoskeletal disorders in this study, future research should consider including physical factors to better understand their impact on these disorders. Additionally, due to the high prevalence of musculoskeletal disorders and the hazardous work environment, ergonomic interventions are recommended to reduce postural stress on the lower back, neck, and shoulders, and to address improper postures during work, following assessments of physical conditions.

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CONFLICT OF INTEREST

There are no conflicts of interest to declare.

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