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Review Article

Musculoskeletal Disorders and Related Risk Factors in Iranian Military Personnel: A Systematic Review and Meta-Analysis

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Abstract

Background: Work-Related Musculoskeletal Disorders (WRMSDs) are prevalent and costly diseases in military occupations. WRMSDs are prevalent and costly diseases in military occupations. We investigated the exposure to ergonomic risk factors and the prevalence of musculoskeletal disorders (MSDs) among military personnel in the workplace.

Method: We aimed to investigate MSDs by conducting electronic searches on Persian databases such as SID, MagIran, and IranMedex, and English databases like PubMed, Web of Sciences, and Scopus. The search was not restricted by time and was conducted until Dec 20, 2021. Two researchers independently extracted the data, and the quality of the research was evaluated using the STROBE checklist. The results of different studies were merged and incorporated into the analysis using Comprehensive Meta-Analysis (CMA) v3 software.

Results: Eleven qualitative studies found that 92% of the respondents were men (83% to 96%). The mean age was 34.17 ± 0.16 yr, with a confidence interval (of 95% CI:33.85-34.48). The mean BMI was 25±0.39 with a confidence interval of 95% CI:24.28-25.84. The mean work record was 12.89±0.81 yr with a confidence interval of 95% CI:11.30-11.48. The highest outbreak of MSDs is in the knee at 38.1% (95%CI:32.1-44.4), 37.6% of the neck (95% CI:24.8-52.5), and 32.5% of the shoulder. (95%CI:22.5-44.3) was observed.

Conclusion: The wide role of various dimensions of work tasks and repetitive tasks (such as lifting, moving or changing positions, standing for long periods, as well as improper postures) in causing WRMSDs. Additionally, the risk factor in the workplace has financial implications for the military organization. The reduction of physical and psychological demands, as well as the improvement of ergonomic standards in the workplace, should be addressed to decrease MSDs in military centers.

Keywords: Ergonomic risk factors; Musculoskeletal disorder; Military; Occupational disease; Meta-analysis

Introduction

With the advancement of technology and the expansion of high-risk industries, organizations also seek to achieve complex and diverse aims for gaining profit and reducing economic losses (1). Occupational health issues have a special place due to the increase in the labor force population (2). Ergonomics and human factors engineering is the science of studying the relationships between people in their workplace. The main aim of ergonomics is to improve the fit and adaptability of humans to the workplace (3). Ergonomics is a science that describes injuries caused to humans in connection with occupational activities, and its main aim is to prevent the incidence of Work-Related Musculoskeletal Disorders (WRMSDs) (4).

WRMSDs can be influenced by different ergonomic risk factors (ERFs) (5,6). WRMSDs are prevalent occupational disorders and disabilities in developed and developing countries (7). ERFs include physical (such as improper posture, lifting and carrying heavy loads, and working with repetitive movements), psychological, organizational, and individual factors (8). WRMSD conditions involve disorders of a group of muscle fibers, tendons, nerves, joints, and discs (9). ERFs, which are responsible for disorders, can cause symptoms including pain, discomfort, injury, tingling, constant pain in body areas, and general disability of body structures (10, 11). Repetitive Motion Injuries (RMIs) are one of the main factors in increasing the risk of WRMSDs (12). WRMSDs are one of the most common causes of occupational disorders among Iranian military personnel (IMP) and affect millions of employees (13).

Many problems caused by the incidence of WRMSDs, including physical, emotional, and occupational problems, and direct and indirect costs, show the need for special study (14). In today's workplace, many factors can affect people who spend more than 8 h per day. In most workplaces, one or several of the five ERFs (physical, chemical, ergonomic, biological, and psychological) affect the employee's health and create the conditions for the incidence of disorders, temporary disability, and pain. WRMSDs in employees may be because of direct combat or occur during deployment or other military and training activities (15). The effect of these disorders leads to the loss of working days, medical expenses, and a decrease in the quality of life of IMP (16).

It is necessary to know the types of disorders that occur and the mechanisms responsible for these disorders, develop strategies to reduce the incidence of disorders, and allocate the financial resources needed for rehabilitation and returning the person to the workplace (17). Human power is the most important capital of any organization, especially military centers (18). IMP is responsible for maintaining the security of the country; therefore, they have needed a high level of body preparation. Their tasks are usually accompanied by stress and tension, which harms their performance. WRMSDs that are caused by work are a significant reason for health care utilization, limited duties, and disability in the Iranian military and other armed forces. Military personnel are affected by musculoskeletal disorders during basic training, operational training, and deployment, which has a direct negative impact on overall troop readiness.

Currently, a systematic overview and meta-analysis study of all risk factors for musculoskeletal disorders in military forces is not available, which is considered one of the main necessities of conducting the present research. This systematic review is focused on examining WRMSDs and ERFs among IMPs in various occupations.

Materials and Methods

A systematic literature search was conducted in accordance with the PRISMA guidelines.

Search strategy

The research conducted on the outbreak of WRMSDs in IMP was analyzed using Persian and English as languages of analysis. A systematic search was conducted in the Persian databases SID, MagIran, and IranMedex and the English databases Web of Science, PubMed, and Scopus with the subject of WRMSDs without a time limit until Dec 2021. Searching for all MeSH terms using the search terms '(military) AND ((injury) OR (trauma)) AND ((pain) OR (physical training)'. The Guidelines for Meta-Analysis of Observational Studies in Epidemiology (MOOSE) for meta-analyses and systematic reviews of PRISMA observational studies were used.

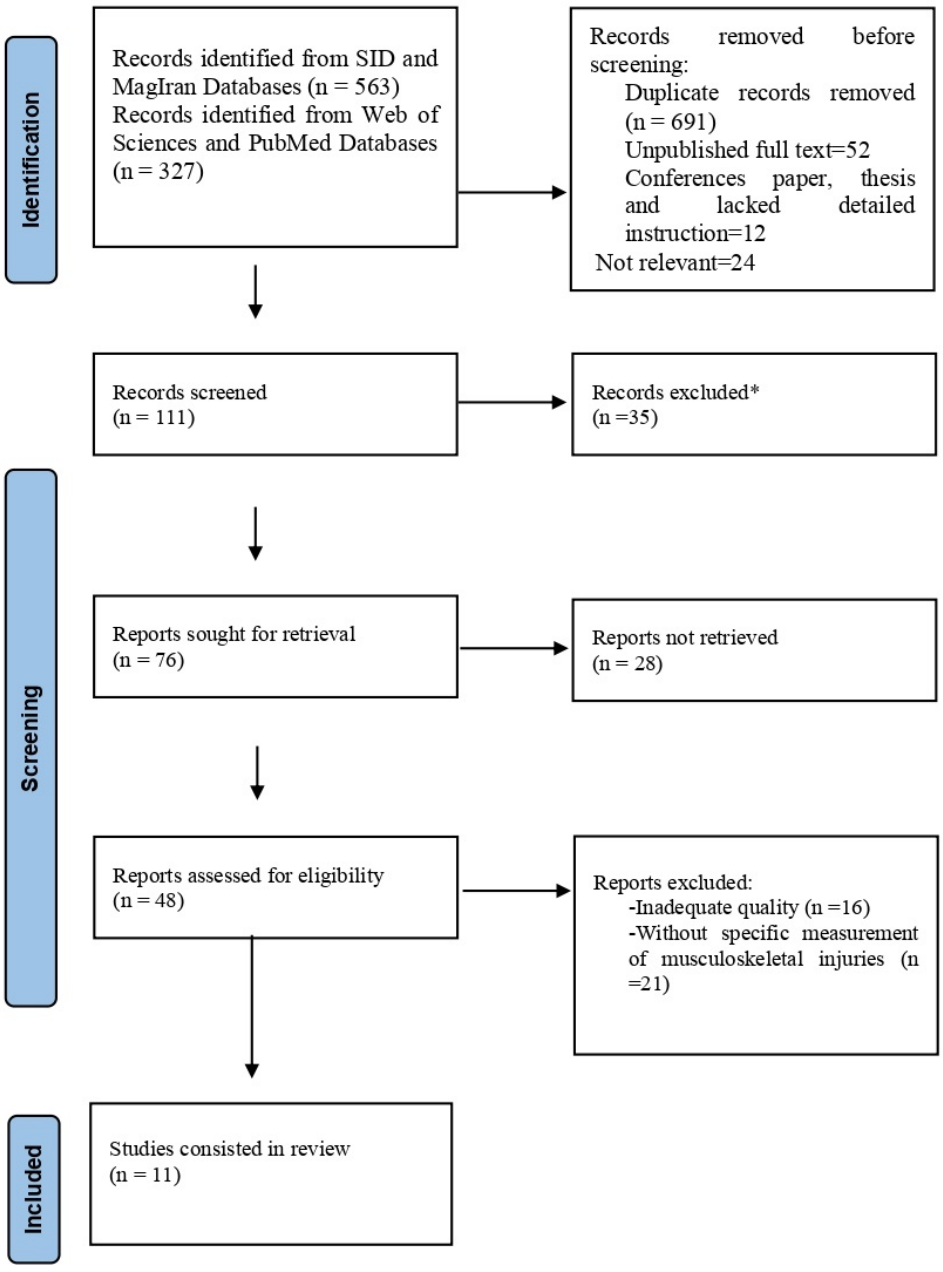

Fig. 1: A schematic diagram of systematic studies

Study selection

Inclusion criteria include cross-sectional studies, prospective cohorts, case-control studies, randomized controlled trials, and articles in English or Persian. Eligible papers according to the two factors of publication in peer-reviewed journals and focusing on the area of MSDs in IMP by reporting at least one of the prevalent WRMSD in the areas of the neck, shoulder, back, or upper limb selected. Additionally, studies of MSDs were selected only if the report was assessed using a previously validated instrument or a new instrument with acceptable validity or reliability scores. WRMSD outbreak estimates in the neck, shoulder, back, and upper and lower limbs were recorded. These areas were selected because they were previously identified as areas of high risk. Tools used to assess were also recorded. The papers were evaluated in terms of the relevance of the abstract to the purpose. Review papers, papers with abstracts, letters to the editor, and conference papers were deleted from the study.

WRMSDs Data Entery

The studies that were included for the definition of disorders had to meet at least one of the following criteria: 1) there was a need for medical care; 2) the disorder was related to military or operational participation; or 3) there was a loss, removal, or need for adaptations to perform the functions for at least 12 h. The studies that were included met at least one of these criteria.

Data extraction and quality assessment

Two independent researchers' extracted data collected from the study outbreaks of MSDs. These consisted of study design, sample size, workplace organization, mean age, percentage of men and women, diagnosis or screening tools, etc. The quality of the final papers was reviewed by two researchers separately. Titles and abstracts were reviewed after removing duplicates. Then the full text of the papers judged to be disqualifying and irrelevant was removed. As shown in Fig. 1, 890 searched papers were included in the Persian and English databases. Based on titles and abstracts, 532 papers were selected. Then there were 111 full-text papers reviewed for eligibility. Finally, 11 papers met the selection criteria. Papers were analyzed quantitatively and qualitatively.

Evidence synthesis

Since the main index investigated in the current study was the outbreak rate, its variance was computed through the binomial distribution, and the 95% confidence limit was considered for the ratio. The outbreak of different studies did combine by using the weighted mean. In other words, each study was given a weight proportional to its variance. Cochran's Q test and the inverse variance method with I^2 were performed to detect heterogeneity between studies. The random effect and fixed effect models were used for estimation because of differences in heterogeneity, respectively. The I^2 is between 0% and 100%, where 0%, 25%, 50%, and 75% mean the absence of heterogeneity, low, medium, and high, respectively (19). If the value of I^2 was greater than 50% or the value of $P<0.01$, the random effect model was used. Otherwise, the fixed effect model was used in data analysis. In the fixed effect model, the weighted mean of the inverse variance was used to estimate the effect size, while in the random effect model, the inverse variance heterogeneity method was used. Studies that reported measures of disability burden or outcomes of ergonomic assessments and interventions were subjected to textual analysis and qualitatively summarized.

Meta-egression

A meta-regression model was used to assess the effect of different factors on the outbreak of MSDs. Data were analyzed by Comprehensive Meta-Analysis Software (CMA v3). A *P*-value less than 0.05 ($P<0.05$) was considered statistically significant.

Results

Search results

The search databases in Persian and English included 1,890 papers (Fig. 1). Overall, 532 papers

were selected based on their titles and abstracts. Then there were 111 full-text papers for their review. Finally, 11 papers met the selection criteria, which were analyzed quantitatively and qualitatively (Table 1).

Characteristics of the participants

The meta-analysis included 11 papers, all of which consisted of 15 cross-sectional designs. Most of the volunteers were men (83%-96%) between the ages of 20 and 50. The mean age was 34.17 ± 0.16 yr with a confidence interval (95% CI=33.85-34.48). The mean BMI was 25±0.39 with a confidence interval (95% CI=24.28-25.84). The mean work record was 12.89±0.81 yr with a confidence interval (95% CI=11.30-11.48). Moreover, the mean height was 175.58 ± 0.18 cm with a confidence interval (CI 95%=175.21-175.94).

Quality control

The six studies were of high quality and low risk of bias (score between 80.0% and 93.0%), three studies of moderate quality and risk of bias moderate (scores between 75.2% and 79.6%), and two studies of low quality and high bias (scores between 61.3% and 69.7%) (Table1).

Table 1: Characteristics of studies of MSDs

Study	*Year*	*Sample Size*	*Occupation*	*Questionnaire Tools*	*Quality(%)*
Saadatian, et al(20)	2021	308	Military Center Officer	Nordic	82.6
Yarandi, et al (21)	2021	316	Flight Security Employees	Cornel	89
Piri, et al (22)	2020	207	Ships Staff	Nordic	80
Alizadeh, et al (23)	2020	564	Military Office Workers	Cornel	93
Golgoli, et al (24)	2018	64	Computer Operators	Nordic	61.3
Yazdanian, et al (25)	2018	66	Military Dentists	Nordic	69.7
Shokati, et al (26)	2018	72	X-Ray Radiographers	Nordic	77
Ashnagar, et al (27)	2017	75	Military Personnel	Cornel	75.2
Ghanbari, et al (28)	2017	70	Military Personnel	Cornel	79.6
Pourtaghi, et al (29)	2015	145	Military Center	Nordic	67
Aghilinezhad, et al (30)	2008	256	Helicopter And Aero Plane Pilots	Nordic	83

Outbreak of WRMSDs

The most prevalent occurrence of WRMSDs is in the knee, with 38.1% (95%CI: 32.1-44.4), 37.6% of the neck (95%CI: 24.8-52.5), and 32.5% of the shoulder. (95%CI: 22.5-44.3) was observed (Table 2).

The overall pooled estimated prevalence of MSDs in the neck was 0.37 (95% CI: 0.24–0.52). This estimation in the shoulder and knee was 0.32 (95% CI: 0.22–0.44) and 0.38 (95% CI: 0.32–0.44), respectively. Other information is shown in Figs. 2, 3, and 4.

Table 2: Outbreak of MSDs in body areas

Area	*Number of studies*	*Sample size*	*Outbreak percentage (95 %confidence interval)*	*P-value*	*Heterogeneity*		
					P	Q	I^2
Neck	11	2143	37.6 (24.8-52.5)	0.101	<0.001	342.95	97.08
Shoulder	11	2143	32.5 (22.5-44.3)	0.004	<0.001	243.03	95.88
Elbow	8	1118	10.3 (5.1-20.0)	<0.001	<0.001	86.72	91.92
Upper back	10	1998	27.4 (16.7-41.6)	0.003	<0.001	279.26	96.77
Wrist	11	2143	25.8 (16.9-37.3)	<0.001	<0.001	260.00	96.15
Waist/low back	11	2143	29.8(20.7-40.9)	0.001	<0.001	237.42	95.78
Thigh/Hips	8	1678	20.1 (11.2-33.5)	<0.001	<0.001	211.68	96.69
Knee	9	1934	38.1 (32.1-44.4)	<0.001	<0.001	55.63	85.62
Legs	8	1678	29.4 (18.8-42.8)	0.003	<0.001	176.77	96.04

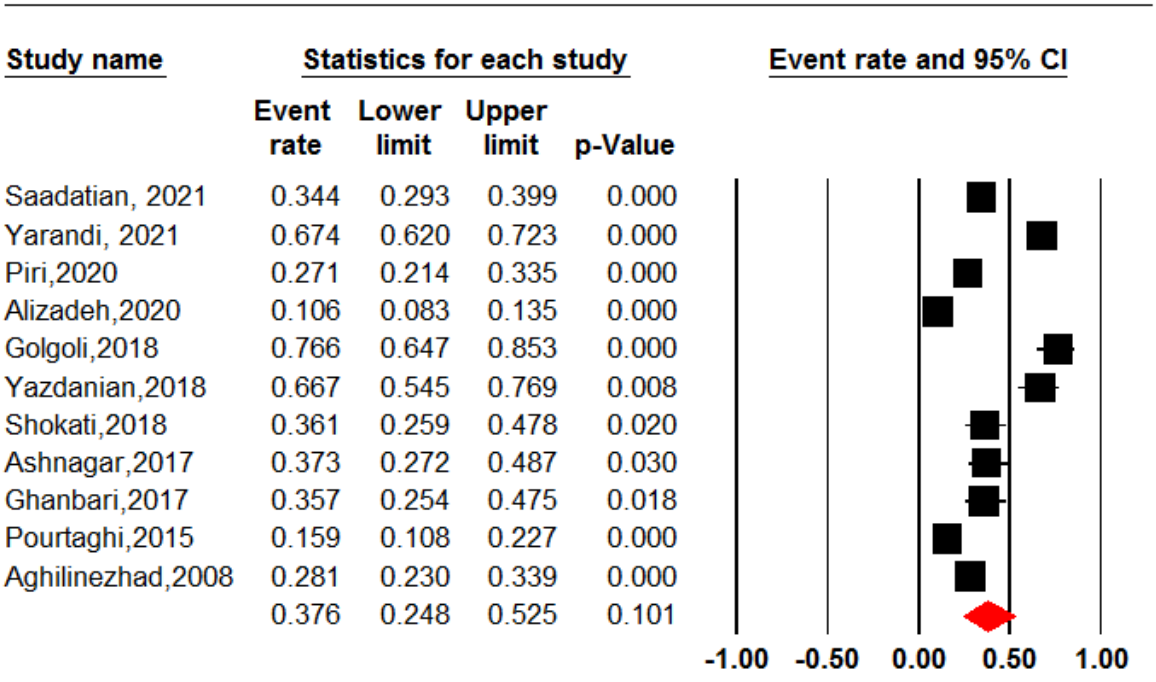

Fig. 2: The outbreak of MSDs in the neck with a random effect model

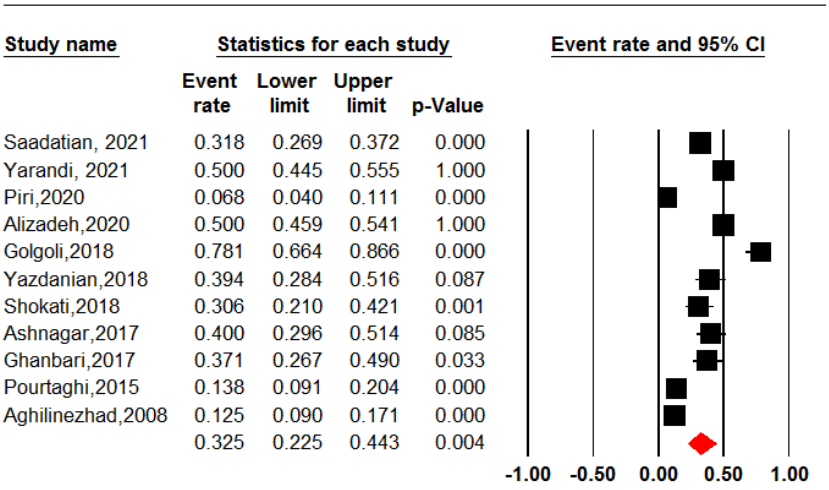

Fig. 3: The outbreak of MSDs in the shoulder with a random effect model

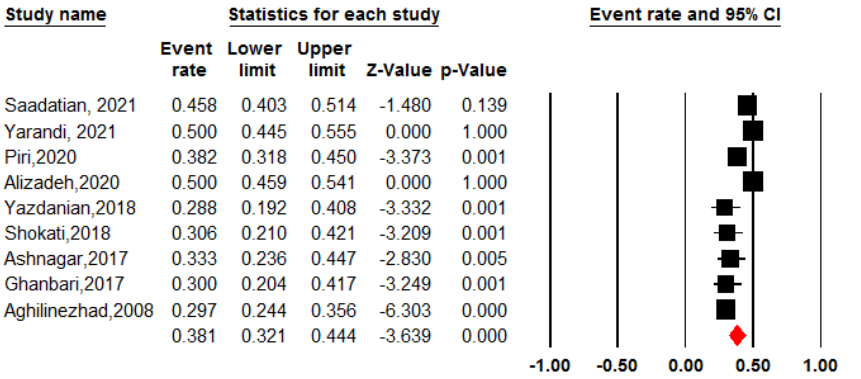

Fig. 4: The outbreak of MSDs in the knee with a random effect model

Meta-regression

The univariate meta-regression test showed no significant relationship between the age and height variables with the outbreak of MSDs (P>0.05). The univariate meta-regression test showed a positive and significant relationship between weight and the outbreak of MSDs in the shoulder, elbow, upper back, wrist, waist, thigh, and legs (P<0.05). In other words, the outbreak of MSDs in the shoulder, elbow, upper back, wrist, waist, thigh, and leg increases with increasing weight (P<0.05). However, there was no statistically significant relationship between weight and the outbreak of MSDs in the neck and knee (P>0.05). The univariate meta-regression test showed a positive and significant relationship between body BMI and the outbreak of MSDs in the upper back, wrists, waist, thighs, knees, and legs (P<0.05). In other words, the outbreak of MSDs in the upper back, wrists, waist, thighs, knees, and legs increases with increase in body BMI (P<0.05). However, there was no statistical-

ly significant relationship between body BMI and the outbreak of MSDs in the elbow, neck, and shoulder (P>0.05). The univariate meta-regression test showed that there is a positive and significant relationship between work records and the outbreak of MSDs in the elbow (P<0.05). In other words, the outbreak of MSDs in the elbow increases with the increasing work records (P<0.05). However, there was no statistically significant relationship between work records and the outbreak of MSDs in the shoulder, neck, shoulder, upper back, wrist, waist, thigh, and legs (P>0.05). The univariate meta-regression test showed a positive and significant relationship between the year of publication of studies and the outbreak of MSDs in the back and knee (P<0.05). In other words, the outbreak of MSDs in the back and knee increased in recent studies (P<0.05). The univariate meta-regression test showed a positive and significant relationship between the year of the study sample size and the outbreak of MSDs in the thigh and knee (P<0.05). The outbreak of MSDs in the thigh and knee has increased with the increase in the study sample size (P<0.05).

ERFs for WRMSDs

In a more thorough study, the lower limbs, waist, upper limbs, and shoulders are the most common organs affected by WRMSDs. Different ERFs are identified in biomechanical groups, workplace design, tools, equipment, environment, time aspects of job design, job content, organizational aspects, economic and financial issues, social aspects, and individual and educational characteristics in the jobs of IMP (Table 3).

Table 3: ERF identified in IMP

First author	*Year of study*	*Occupation type*	*Identified ERF*
Asadi et al.(31)	2021	Military soldiers	Vibration, the speed at work, job stress, and lack of proper training on how to move and carry loads
Jafari et al. (32)	2020	Soldiers of the military barracks	Improper physical condition and failure to perform corrective sports exercises
Pourtaghi et al. (33)	2019	Personnel of small marine vessels	Inappropriate design, including the small entrance door to the cabin, the small entrance door for the rest room and its low height, the inappropriateness of the seats installed on the float, the shortness of the roof in roofed floats and carrying heavy loads, and the short periods of work and rest.
Ahmadi et al. (34)	2019	Military pilots	Cold or hot temperature, weight, BMI, and somatotype as individual characteristics
Bahiraei et al. (35)	2019	Aja headquarters staff	Failure to screen and identify people with musculoskeletal disorders and not considering motor screening scores and traumatic risk factors
Yasi et al. (36)	2017	Air Force personnel	Lack of ergonomic training in the workplace
Zarei et al. (37)	2016	Officer students	Incompatibility of the intensity and duration of basic military exercises with ergonomic principles
Beyranvand et al.(38)	2016	Ndaja sub-level staff	Hard-working conditions and unsuitable workplace
Majidi et al. (39)	2013	All military personnel	The inappropriateness of equipment and necessities, including backpacks of military forces
Shokoohi et al. (40)	2010	Payvar Aja staff	Improper design of equipment, weapons, military equipment, and combat clothing according to the physical dimensions of the employees
Jahani et al. (41)	2000	police personnel	Lack of proper planning to maintain the health of personnel

Discussion

In this study, 11 selected papers were examined, and the most effective ERFs in WRMSDs were analyzed. All types of musculoskeletal disorders are found in male IMP, and fewer studies have focused on the outbreak of WRMSDs in female IMP. IMPs have a high level of physical activity and a high prevalence of WRMSDs.

Among the ERFs related to the organizational aspect, conducting periodical and pre-employment examinations has an effective role in identifying people with WRMSDs. In the classification of ERFs related to training in military organizations, the lack of employees' awareness of other ergonomic principles of the workplace has a greater contribution.

In the investigation of the reasons for referral to medical centers during the period of combat training, the reason for referral was primarily physical damage, especially WRMSDs, and secondarily respiratory infections (42). Knee arthritis leads to a reduction in the efficiency of IMP in the workplace. Consistent with these research results, regard must be paid to screening chronic knee arthritis and other WRMSDs before recruitment into the armed forces (43). In the trial study on military soldiers, knee pain was one of the prevalent disorders. Moreover, that research emphasized musculoskeletal screening, including medical examinations (44). Investigating the possible causes and factors of combat sports disorders in female police students, the injury cases according to location were spine, lower limb, and upper limb, respectively. The knee injury was the most prevalent type of injury in the first year of training, in the next year, and at the end of the course, in the back injury. Predisposing factors were found to consist of soft tissue, joints, women, physiological body disorders, and bone problems in order of frequency. Predisposing factors at the end of the course consisted of physiological disorders of the body, soft tissue problems, women, and joint and bone problems (45).

Ghanjal et al.'s study showed a significant relationship between occupation, work type, and spinal discopathy in male IMP. Periodical examinations, selecting personnel compatible with their physical condition, correcting their work situations, training, observing ergonomic principles, and performing sports exercises were suggested (46). The effect of an eight-week prevention program on the efficiency and musculoskeletal pain of military students was studied, and our study showed that the practice protocol is useful for reducing pain and improving the work performance of students (47).

In Kangarlo et al.'s study on the outbreak of WRMSDs leading to disability in Air Force personnel, joint diseases ranked second among all problems after disc disorders (48).

Appropriate use of physical standards, injury prevention, preventive measures, physical fitness training, a balanced physical fitness program, and appropriate sports exercises can be effective in reducing WRMSDs in IMP. Carrying heavy backpacks for long distances should be prohibited, and backpacks with a suitable weight should be prepared. Therefore, at the beginning of service, monitoring IMP based on the above-mentioned characteristics and employing them in accordance with the results of monitoring and their abilities during the service by using preventive interventions will be effective in reducing the incidence of WRMSDs. In the administrative staff of military centers, the educational intervention based on improving the ergonomic condition of the computer staff was effective. Of course, more research should be done to confirm the results of other computer workers (49).

The most important reason for referring to medical clinics is physical impairment. WRMSDs are prevalent among training soldiers at 96.2%. During sports activities, the most affected area is the lower limb, which appears in military training personnel (50).

Limitations

The data were collected by the self-report method, so the participants' answers may not be true.

The bilingual nature of the reviewed studies (English and Persian) may have affected the researcher's understanding.
Subgroup analysis, sensitivity analysis, and meta-regression were used to identify sources of heterogeneity. A certain degree of heterogeneity may reduce the accuracy of the estimation.
It was unreasonable to use different questionnaires and measurement standards to test the same outcome indicators.
More studies should be included. In future research, more theoretical and experimental research can be considered.

Conclusion

Outbreaks of back, neck, shoulder and knee pain in IMP are high. Pain in the lower back may be reduced by designing an appropriate chair for rest. Knee pain can be controlled by decreasing the pressure on the legs and getting enough rest. Studies conducted to study the outbreak and determine the FRFs of WRMSDs demonstrate the significance of this type of disorder. Healthcare is one of the health management solutions. Regular examinations are recommended as part of the health program for IMP. The training workshop appears to be required to familiarize employees with the ergonomic principles of the military work environment.
Moreover, stretching movements and effective rest reduce the risk of WRMSDs. Regular exercise, fitness, and periodic medical supervision is suggested during years of service to prevent WRMSD.

Journalism Ethics consideration

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors. This research is approved by ethical committee of Ardabil University of medical sciences code: IR.ARUMS.REC.1403.121.

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Conflict of interest

The authors declare that there is no conflict of interests.

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