

INCIDENCE RATE OF MUSCULOSKELETAL INJURIES IN BRAZILIAN ARMY

TAXA DE INCIDÊNCIA DE LESÕES MUSCULOESQUELÉTICAS NO EXÉRCITO BRASILEIRO

Eduardo Borba NEVES¹; Rafael Chieza Fortes GARCIA²; Rafael Melo de OLIVEIRA³; Eduardo Camillo MARTINEZ⁴;

1. Fisioterapeuta, Doutor em Engenharia Biomédica, Instituto de Pesquisa da Capacitação Física do Exército -IPCFEX, Rio de Janeiro, RJ, Brasil; 2. Médico, Especialista em Medicina Física e Reabilitação - IPCFEX, Rio de Janeiro, RJ, Brasil; 3. Educador Físico, Mestre em Ciências da Atividade Física - IPCFEX, Rio de Janeiro, RJ, Brasil; 4. Educador Físico, Doutor em Saúde Pública - IPCFEX, Rio de Janeiro, RJ, Brasil.

ABSTRACT: The incidence of musculoskeletal injuries (MSIs) is a constant concern in all Armed Forces. Among risk factors for MSIs, physical training and sports can be considered the most frequent cause in military. In this sense, the aim of this study was to investigate the incidence rate of musculoskeletal injuries, identifying the anatomical distribution and its association with risk factors such as: body composition, age and physical training over the past 12 months. Three hundred fifty-one male cadets from the first year of the Brazilian Army officers training course and four hundred and fifty six students from the logistics sergeants training course (three hundred seventy-five male and eighty one female) volunteered to fill in a self-reported questionnaire which was developed based on a literature review and the clinical experience of the investigators. It contained questions concerning anatomical site of the MSIs, hours of physical activities per week, type of activities at the moment of injury and days of absences in physical activities. Among 807 subjects studied, 180 military have reported 220 MSIs. From this total, 143 have presented a single injury, 34 have suffered two injuries and three subjects have had three injuries each one during the last 12 months. Knee was the anatomical site with the higher incidence (7.06%) of MSIs over a 12-month period. Running was the activity with the higher incidence (11.77%) of injuries over a 12-month, accounting for 43.18% of all MSIs. When considered all activities of physical training, the MSIs incidence rate over a 12-month was 17.97%, which represents 71.36% of all MSIs. In young militaries, the largest amount musculoskeletal injuries occurred in the lower extremities and during military physical training, with running being the main activity in which the injuries occurred. Population, gender and body composition was not significantly associated with these types of injuries, while older age was associated in this study. The gradual and systematic progression of distance and speed during running training should be emphasized to prevent MSIs.

KEYWORDS: Musculoskeletal injuries. Military personnel. Epidemiology. Risk factors. Wounds and injuries.

INTRODUCTION

The incidence of musculoskeletal injuries (MSIs) is a constant concern in all Armed Forces. Several countries have developed studies to identify risk factors for the occurrence of injuries. Some of them are already testing strategies to minimize these risk factors, and therefore, the incidence of this type of injury (KOTWAL, 2012; GOODALL et al., 2013; BULZACCHELLI et al., 2014).

The Brazilian Army (BA) currently has approximately, 220.000 militaries on its permanent staff. Daily military activity covers a variety of situations ranging from administrative work to operational activities with high physical demand (NEVES, 2007; NEVES; MELLO, 2009). The physical preparation is one of the principal responsibilities of the military work, not only during possible conflicts, for which they must always be prepared, but also in times of peace, requiring them high level of physical and mental health (NEVES; MELLO, 2009; ORR et al., 2015).

Authors describe: sociodemographic characteristics, body mass index, medical history, cardiovascular fitness, neuromuscular fitness, gender and lifestyle factors as the main risk factors to development of MSIs (BULZACCHELLI et al., 2014; KODESH et al., 2015). Among these risk factors, physical training and sports can be considered the main cause of MSIs. Nindl et al. (2013) investigated the causes of non-battle injuries (NBIs) which have promoted medical evacuations from recent US Army theaters of operation and they reported most of MSIs (56%) was directly related to physical training. Same authors support higher levels of physical fitness can act as protect factor against MSIs, however, physical training in excess, aiming to improve fitness can raise injury rates.

There are evidences that the body mass index is also a risk factor for injuries (KNAPIK et al., 2013; KNAPIK, 2015). However, there are few studies on the incidence of lesions in the Brazilian army, and they are restricted to small specific sub-populations, such as the paratroopers (NEVES et al.,

2009; NEVES et al., 2010). In this sense, the aim of this study was to investigate the incidence rate of musculoskeletal injuries, identifying the anatomical distribution and its association with risk factors such as: body composition, age and physical training over the past 12 months.

This knowledge is a crucial step to plan strategies to reduce physical training related injuries and may reduce the time out of work, health costs and discharges from the Army. In this sense, the aim of this study was to investigate the incidence rate of musculoskeletal injuries, identifying the anatomical distribution and its association with risk factors such as: body composition, age and physical training over the past 12 months.

MATERIAL AND METHODS

Three hundred fifty-one male cadets from the first year of the Brazilian Army officers training course and four hundred and fifty six students from the logistics sergeants training course (three hundred seventy-five male and eighty one female) volunteered to participate in the study. The inclusion criteria were: the participant should have more than one and less than two years of experience in military activities, and should be volunteers to fill out the self-reported questionnaire. Following an explanation of all procedures, risks and benefits, each volunteer signed their informed consent form to participate in the study. The study protocol followed the procedures of the Helsinki declarations and it was approved by a Human Research Ethics Committee under CAAE number 53694016.9.0000.5250. The anthropometric characteristics of the sample were (average \pm standard deviation): male [age of 21.14 ± 2.12 years; weight of 72.94 ± 8.18 kg, height of $1.76 \pm$

0.06 meters, body mass index of 23.53 ± 2.00] and female [age of 23.51 ± 2.51 years; weight of 61.30 ± 8.46 kg, height of 1.64 ± 0.07 meters, body mass index of 22.74 ± 3.00].

Information were collected by self-reported questionnaire which was developed based on a literature review and the clinical experience of the investigators (PATTUSSI et al., 2008; PAPACHRISTOS et al., 2014). It contained questions concerning anatomical site of the MSIs, hours of physical activities per week, type of activities at the moment of injury and days of absences in physical activities.

Descriptive statistics were used to summarize the characteristics of the studied sample and Shapiro-Wilk test was performed to exam the variables distribution (RAZALI; WAH, 2011). Pearson qui-square test (χ^2) was used to compare the Incidence rate (%) of MSIs among anatomical site of MSIs, type of activities at the moment of injury and gender. The relative risk (RR) for MSIs was calculated for subgroups (determined by the quartiles (KNAPIK, 2015)) stratified by age, hours of physical activities per week and body mass index. The Statistical analyses were performed with Statistical Package for Social Sciences (SPSS, version 21.0). The statistical significance level was defined as $p < 0.05$.

RESULTS

Among 807 subjects studied, 180 military have reported 220 MSIs. From this total, 143 have presented a single injury, 34 have suffered two injuries and three subjects have had three injuries each one. Table 1 shows the injuries prevalence according to anatomical site, as well as averages of time away from physical activity.

Table 1. MSIs incidence over a 12-month period and time away from physical activity according to anatomical site from 180 military of 807 studied, 2015, Brazil.

Anatomical Site	N	Incidence rate (%)	Days of absence from physical training/sport (Average \pm SD)
Head	3	0.37	19.33 \pm 14.36
Neck	1	0.12	7
Trunk	8	0.99	25.13 \pm 51.02
Shoulders	37	4.58	16.68 \pm 22.85
Arm / Elbow	4	0.50	34.50 \pm 40.72
Wrist / Hands	11	1.36	22.00 \pm 28.06
Hip	4	0.50	20.25 \pm 20.84
Thigh	6	0.74	17.67 \pm 23.10
Knee	57	7.06	24.19 \pm 41.03
Leg	22	2.73	17.38 \pm 21.64
Ankle	47	5.82	19.96 \pm 20.49
Feet	20	2.48	15.60 \pm 14.18

There was a significant difference among the Incidence rate (%) of MSIs in each body region $\chi^2(11) = 214.98$ ($p < 0.001$) and also when considered the six most frequents (Shoulders, Wrist / Hands, Knee, Legs, Ankle and Feet) $\chi^2(5) = 49.91$

($p < 0.001$). Knee was the anatomical site with the higher incidence (7.06%) of MSIs over a 12-month period. The sample was also stratified by type of activities at the moment of injury. These results were presented in Table 2.

Table 2. MSIs incidence over a 12-month period according to type of activities at the moment of injury from 180 military of 807 studied, 2015, Brazil.

Type	Activity	N	Incidence rate (%)
During military activities	Camp activity	27	3.35
	Physical training (pull up)	5	0.62
	Physical training (running)	95	11.77
	Physical training (collective sports)	22	2.73
	Physical training (individual sports)	18	2.23
	Physical training (military pentathlon obstacle run)	5	0.62
	Military instructions	29	3.59
	Others military activities	3	0.37
Out of military activities	Running	6	0.74
	Physical training (collective sports)	3	0.37
	Physical training (individual sports)	3	0.37
	Others activities	4	0.50

There was a significant difference among the proportions of MSIs during military activities $\chi^2(7) = 245.49$ ($p < 0.001$). Running was the activity with the higher incidence (11.77%) of injuries over a 12-month, accounting for 43.18% of all MSIs. When considered all activities of physical training, the MSIs incidence rate over a 12-month is 17.97%, which represents 71.36% of all MSIs.

Of the 807 subjects studied, women reported a MSIs incidence rate of 28.22% and men presented an incidence rate of 27.13%. There is no significant difference in MSIs incidence rate between gender $\chi^2(1) = 0.02$ ($p = 0.877$). Table 3 presents the Relative Risk (RR) analysis when the sample was stratified by gender and quartiles of age, hours of physical activities per week, and Body Mass Index (BMI).

Table 3. Relative Risk analysis for MSIs risk factors (age, hours of physical activities per week, and Body Mass Index) for 807 military from Brazilian Army, 2015.

variable	Gender	Quartile	Range	RR	Confidence Interval	
Age (years)	Male	1	16-20	1.003	0.705 - 1.426	
		2-3	20-23	1.000	Reference	
		4	23-27	1.382	1.015 - 1.883*	
		1	17-21	2.143	0.970 - 4.733	
	Female	2-3	21-26	1.000	Reference	
		4	26-27	0.500	0.117 - 2.139	
		Male	1	2-6	1.209	0.870 - 1.679
			2-3	6-10	1.000	Reference
4	10-28		1.230	0.887 - 1.703		
Hours of physical activities per week (hours)	Female	1	2-5	2.050	0.756 - 5.558	
		2-3	5-10	1.000	Reference	
	Male	4	10-15	2.392	0.925 - 6.187	
		1	19.0-22.0	1.169	0.839 - 1.627	
Body Mass Index	Male	1	19.0-22.0	1.169	0.839 - 1.627	

	2-3	22.0-24.9	1.000	Reference
	4	24.9-32.2	1.223	0.884 - 1.692
	1	17.0-20.1	1.281	0.480 - 3.418
Female	2-3	20.2-25.0	1.000	Reference
	4	25.0-30.4	1.281	0.480 - 3.418

* Statistical Significance

DISCUSSION

To the best of our knowledge, the present study is the first of this type trying to identify MSIs incidence rate and relative risk among Brazilian Army officers and sergeant students. For the same reason, the comparison of the MSIs incidence rate found of 27.13% and 28.22% for men and women respectively, with similar studies in Brazil was impaired. Previous studies in US military, the injury incidence rate have ranged from 27% (BELL et al., 2000) and 42% for men (JONES et al., 1993; KNAPIK et al., 2013) and 30% (Roy et al., 2014) and 57% (Bell et al., 2000) for women. Most of these studies (JONES et al., 1993; BELL et al., 2000; KNAPIK et al., 2013) followed up the soldiers during a Basic Combat Training comprising 8 to 12-week activity program. These short and high physical demanding program contrasts with the not so intense program of officer and sergeant training courses in Brazilian Army. That could explain why the MSIs incidence rate of 27% for men is in the lower limit range and incidence rate of 28% of women is lower than the rate found in past studies among military. As previous demonstrated (KNAPIK et al., 2007), different militaries occupational specialties have different physical demands, where those with higher physical demands shows higher injury incidence rate.

Concerning to the body region affected by MSIs, the lower extremities accounted for 68% of all injuries reported, being knee (25.9%) and ankle (21.3%) the most affected. Others studies (JONES et al., 1993; ALMEIDA et al., 1999; ROY et al., 2014) also reported a predominance of lower extremities injuries, with a prevalence ranging from 46.5% to 82%.

Analyzing the days away from the physical training, it is possible quantify the severity of injury and the potential impact on the military healthiness and physical fitness. Although not the most common anatomical site of injury, elbow and arm accounted for the largest number of absent days from physical

activity, with an average of 34 days. Knee, with an average of 24 days of absence of physical activity, has the highest incidence of injuries (7.06% of all injuries) and grows in importance since it has the largest sum of days away from physical training. In the US military, Ruscio et al. (2010) demonstrated that lower extremities injuries were the main cause of the absence of physical activity, with an average of 14 days for overuse injuries and 120 days for fractures. In the same direction, Peake et al. (2012) showed that the amount of restricted work days by MSIs ranged from 10 to 25 days according to body weight in Australian military, although that correlation (body mass and restricted work days) was not statistically significant.

About risk factors for exercise-related injuries, although other studies have reported an extensive list of risk factors, the present study is focused on age, gender, body mass index and weekly time spent in physical activities. Of those, only older age shows a statistical significance relative risk. The finding that older militaries have higher risk than young for develop a MSIs is consistent with many others previous studies (JONES et al., 1993; HEIR; EIDE, 1997; KNAPIK et al., 2013; ROY et al., 2014). As proposed by Knapik et al. (2013), the reason for that may have to do with age-related changes in tissue repair mediated by stem cells which could make these individuals more susceptible to injuries caused by overuse. In the present study, the relative risk of 1.38 could be higher if the age range was wider, since the difference between the oldest and youngest participants was only 11 years.

Regarding to factor gender, in present study, this variable was not associated with incidence of MSIs. Bell et al. (2000) reported that gender, after controlled by level of fitness, is not significantly associated with training-related injury. In the same direction, Blacker et al. (2008) suggest that gender alone is not a significant risk factor for MSIs in female recruits. One possible reason for this lies in the fact that men and women had approximately the

same level of fitness at the beginning of the training course, as there are eliminatory physical tests during the selection process to access these courses. Another factor that may have contributed is that the physical tests during those courses are proportional to the gender (a bit less for women).

In the analysis of body composition, although other studies in the past have shown an increased risk of MSIs for individuals in the lower and upper extremes of BMI (HEIR; EIDE, 1997), this association with injury risk was not found in this study. Other more recent studies using multivariate regression analysis, also did not find this association (ROY et al., 2014). Possibly the individuals who have the highest BMI are the same who did less physical activity and have the lower levels of physical fitness. Another factor that may have contributed to this lies is the great homogeneity of the military sample. With a mean BMI 23.53 ± 2.00 (standard deviation), quartile analyzed were very similar from a physiological point of view.

Activities which most contributed to MSIs were those related with military physical training or military combat simulation. In present study, as other authors reported (ROY et al., 2014), running during physical training was by far the most representative activity accounting for 43% of all injuries. We cannot disregard the fact that, at Officer and Sergeant Training Courses in Brazilian Army, the running test is one important part of the physical fitness evaluation process of the student and may have future influence on their careers in the Brazilian Army. At these courses, the highest score that a student can achieve corresponds to the 95th percentile of normative values proposed by the ACSM (2013) for the 12-minute run test. Therefore, in order to achieve better running performance, these military could carry out some kind of unbalance in the triad volume-intensity-rest, which can lead to MSIs. This idea is reinforced by (KNAPIK et al., 2013) when, despite have studied a

less prolonged military course, he also identified military physical training as the leading cause of injuries during the 8-week program of Basic Combat Training for US Army recruits.

As the time spent in physical activities and all other variables were measured by a recall self-reported questionnaire, the questions were simple and easy to remember in order to avoid blank answers. So as only the total hours spent in aerobic or neuromuscular activities was requested, it was not possible to calculate the incidence relative to each subtype of activity per unit of time, making it difficult to compare with other studies. This can be cited as a limitation of this study.

From all the results found in this study, the fact of the lower extremities and running training are the main parts involved in the largest number of injuries in young soldiers. It reinforces the importance of care to avoid excessive physical training. Following the proposed by Bullock et al. (2010), the main strategy for injuries prevention is to avoid overtraining. Good evidences was found that physical training programs, especially in initial military training, when started with lower mileage and intensity reduce injury rates while maintaining or improving physical fitness.

CONCLUSIONS

For newly incorporated military, the largest amount musculoskeletal injuries occurred in the lower extremities, and during military physical training, with running being the main activity in which the injuries occurred.

Population, gender and body composition was not significantly associated with these types of injuries, while older age was associated in this study. Whole work load during the week and Gradual and systematic progression of distance and speed during running training should be emphasized to prevent MSIs.

RESUMO: A incidência de lesões musculoesqueléticas (LME) é uma preocupação constante em todas as Forças Armadas. Entre os fatores de risco para LME, treinamentos físicos e esportes podem ser considerados a causa mais frequente em militares. O objetivo deste estudo foi investigar a taxa de incidência de lesões musculoesqueléticas, identificar a distribuição anatômica e sua associação com fatores de risco, tais como: composição corporal, idade e treinamento físico nos últimos 12 meses. Trezentos e cinquenta e um cadetes do primeiro ano da Escola Preparatória de Cadetes do Exército brasileiro e quatrocentos e cinquenta e seis alunos do curso de Sargento logístico (trezentos e setenta e cinco homens e oitenta e uma mulheres) se ofereceram para preencher um questionário auto relatado que foi desenvolvido com base em uma revisão da literatura e a experiência clínica dos pesquisadores. Ele continha perguntas sobre o local anatômico das LME, horas de atividades físicas por semana, tipo de atividades no momento da lesão e dias de ausência em atividades físicas. Entre 807 sujeitos estudados, 180 militares relataram 220 LME. A partir deste total, 143 apresentaram uma única lesão, 34 sofreram duas lesões e três indivíduos tiveram três lesões cada nos últimos 12 meses. O joelho foi o local anatômico com maior incidência (7,06%) de LME ao longo de um período de 12 meses. A corrida foi a atividade

com maior incidência (11,77%) de lesões ao longo de 12 meses, representando 43,18% de todas as LME. Quando considerado todas as atividades de treinamento físico, a taxa de incidência de MSI ao longo de um período de 12 meses foi de 17,97%, o que representa 71,36% de todas as LME. Em militares jovens, a maior quantidade de lesões musculoesqueléticas ocorreu nas extremidades inferiores e durante o treinamento físico militar, sendo a corrida a principal atividade na qual ocorreram as lesões. População, gênero e composição corporal não foram significativamente associados a esses tipos de lesões, enquanto a idade avançada foi associada neste estudo. A progressão gradual e sistemática da distância e da velocidade durante o treinamento em corrida deve ser enfatizada para evitar LME.

PALAVRAS-CHAVE: Lesões musculoesqueléticas. Militar. Epidemiologia. Fatores de risco. Feridas e lesões.

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