FATORES DE RISCO PARA LESÕES MUSCULOESQUELÉTICAS EM ADOLESCENTES NUMA ESCOLA MILITAR DO BRASIL

Risk factors for musculoskeletal injuries in freshman teenagers at a Brazilian military school

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RESUMO

Objetivos: determinar a prevalência de lesões relacionadas ao treinamento físico ocorridas em uma escola militar; investigar os fatores de risco para lesões musculoesqueléticas em geral e para a lesão mais prevalente observada nessa população, e avaliar a qualidade de vida de participantes lesionados e a melhora da qualidade de vida após tratamento. Métodos: 498 estudantes militares foram investigados durante período de 11 meses e foram submetidos, no início do serviço militar, a avaliações, incluindo testes de condicionamento físico e avaliações antropométricas. As variáveis avaliadas foram: teste de corrida, flexão de braços, barras, abdominais, natação, peso, altura e índice de massa corporal. Os dados de lesão foram registrados no serviço de fisioterapia da escola, e a comparação entre os grupos de lesionados e não lesionados foi realizada. A qualidade de vida dos estudantes lesionados foi avaliada usando o questionário SF-36, que foi aplicado novamente trinta dias após o início do tratamento. Resultados: Lesões musculoesqueléticas ocorreram em 28,31% dos estudantes. 62.41% dessas lesões foram lesões por sobrecarga, enquanto 37.58% foram macrotraumáticas. Síndrome do estresse tibial medial foi a lesão mais prevalente observada. Nenhuma das variáveis estudadas representou fator de risco para lesões musculoesqueléticas em geral. Baixo índice de massa corporal e baixo peso foram fatores de risco para síndrome do estresse tibial medial. A qualidade de vida dos participantes lesionados melhorou substancialmente após tratamento.

Palavras-chave: esportes, transtornos traumáticos cumulativos, fisioterapia.

ABSTRACT

Objectives: The purpose of this study was to determine the injury rates related to physical training occurring at a military school, to investigate the risk factors for musculoskeletal injuries in general and for the most prevalent musculoskeletal injury observed in this population, and to assess the quality of life of injured participants and the improvement in quality of life after treatment. Methods: In this study, 498 military students were investigated during an 11-month period and were subjected at the beginning of the military service to evaluations, including physical fitness tests and anthropometric measurements. The variables included in the model were: running test, push-up test, pull-up test, sit-up test, swimming test, height, weight, and body mass index. The injury data were obtained in the physiotherapy service, and a comparison between the injured and uninjured group was conducted. The quality of life of the injured participants was evaluated using the SF-36 questionnaire, which was applied again thirty days after treatment had begun. Results: Musculoskeletal injuries were exhibited by 28.31% of the students. Of these injuries, 62.41% were overload injuries, and 37.58% were traumatic. Medial Tibial Stress Syndrome was the most prevalent injury. None of the studied variables represented risk factors for musculoskeletal injuries in general. Lower body mass index and lower weight were found to be risk factors for Medial Tibial Stress Syndrome. The quality of life of the injured participants improved substantially after treatment.

Keywords: Athletics, Lower extremity injuries, Physiotherapy

INTRODUCTION

Considering the high level of physical demand related to the military profession, the personnel recently engaged in physical fitness programmes can suffer from many injuries (MORKEN, et. Al., 2007, MEHRI, et. al., 2010).

It is commonly agreed that most musculoskeletal injuries observed in athletic and military populations affect the lower limbs, (MEHRI, et. al, 2010, CHAN, et. al., 1993) and the literature highlights the fact that many of these injuries are related to sustained continual training, for example, running training (NICHOLL, et. Al., 1995, BREDEWEG, et. al., 2010). Also overload injuries are more prevalent than traumatic injuries in runners and in the military population (POPOVICH et. al., 2000, FALLON, 1996). Musculoskeletal injuries related to physical training are the main cause of premature discharge from military service and temporary disabilities from physical conditioning programmes (TAANILA et. al., 2011).

Despite several previous studies have sought to verify the effectiveness of some interventions in reducing the injuries in this population (BREDEWEG et. Al., 2010, YEUNG e YEUNG, 2001, KNAPIK et. Al., 2004), there is still a lack of knowledge in the literature regarding the aetiology of exercise related to musculoskeletal disorders (BREDEWEG, et. al.,2010, THACKER et. al., 2001).

The aim of this prospective study was to verify the prevalence of musculoskeletal injuries occurring in students in military service over an eleven-month period. The second objective was to identify the risk factors for injuries in this population and to identify the risk factors for the most often observed injury occurring among the participants. We also analysed the impact of these musculoskeletal injuries on the quality of life of the injured participants and the changes in quality of life after physiotherapy treatment.

METHODS

This was an observational and prospective study. The study was conducted at Escola Preparatória de Cadetes do Exército (EsPCEx), located in Campinas in the state of São Paulo, Brazil. 525 male subjects starting military service as students were invited to participate in this research and 498 (94.8%) agreed to participate and signed an informed consent form. The participants were born in different Brazilian states and came from different regions of the country. The study was approved by the local institutional review board. The participants were observed from February to December 2010.

Physical evaluation:

At the very beginning of military service, the participants submitted to a physical fitness test and anthropometric measurements in order to verify the students' physical fitness and anthropometric profile. The following physical performance tests were conducted:

3000-Metre Running Test: the time to complete 3000 metres was recorded for all participants in seconds.

Pull-Up Test: they raised their body high enough to pass the chin over a bar and then returned to the starting position with elbows fully extended. The total number of repetitions was recorded.

Push-Up Test: in a face-down position. The number of consecutive repetitions was registered.

Sit-Up Test: lying supine on the floor, the subject raised the upper body until the scapula lost contact with the appraiser's hand. The number of consecutive repetitions was registered.

50-Metre Swimming Test: measured in seconds. The students who did not know how to swim were excused from this test.

Anthropometric measurements included height (metres), using the same stadiometre, and weight (Kg), using the same digital balance. Body mass index (BMI) was calculated as weight/height^2 in Kg/m^2.

Daily Routine

After the students finished all the assessments, they were divided into three companies (168 in the first company, 169 in the second and 161 in the third) and engaged in regular activities in the classroom and in military physical training. A number of students were also selected to participate in sports practices, composing the teams to represent the school in competitions.

Injuries and Treatment

Many students presented musculoskeletal injuries during the period and after the medical diagnosis, they were referred to the physiotherapy service.

At the physiotherapy service, the medical diagnosis was registered, and the patients were requested to fill out the SF-36 life quality questionnaire before engaging in any type of physiotherapy treatment. After 30 days, the students filled it out again. The treatment methods were chosen by the responsible physiotherapists for each case according to the diagnosis.

After the 10^{th} month, the anthropometric and physical fitness test data were compared between the students who experienced any kind of musculoskeletal injury during the year and the uninjured group. The data from the subjects who presented the most prevalent kind of injury were also compared to the uninjured group. Finally, we compared the SF-36 data from the first to the 30^{Th} day.

Statistical Analysis

To compare the continuous or rankable measures between two groups, the Mann-Whitney Test was applied. Univariate and multiple Cox regression analysis was used to identify the risk factors for musculoskeletal injury and the risk factors for the most prevalent musculoskeletal injury. A *stepwise* process was used to select the variables. The Wilcoxon test was applied to compare the life quality variables between the two evaluated moments. The adopted level of significance for the statistical tests was 5%. The activities in the study are specified in the figure 1.

RESULTS

The age of the participants ranged from 15 to 22 (mean age: 18). From the sample of students, 141 (28.31%) sought treatment from the physiotherapy service, due to musculoskeletal injury (table 1).

Table 1 *amount of subjects who sought treatment due to musculoskeletal injury*

Injury occurrence	Quantity	Percentage
Yes	141	28.31%
No	357	71.69%
Total	498	100%

Of the injured subjects, 62.41% (n=88) were diagnosed with overload injuries, while 37.58% (n=53) presented traumatic injuries, showing that overload injuries are more prevalent in this population. The most common musculoskeletal injuries observed in this study are shown in figure 2.

Medial tibial stress syndrome (MTSS) was the most prevalent of all the injuries seen and was observed in 24.1% of the injured group. MTSS was diagnosed in 34 subjects, which represents 6.83% of the studied population.

Comparing the physical fitness test and anthropometric data between the students who had musculoskeletal injuries in general and the uninjured group, no statistical significance was observed for any of the variables studied by the Mann-Whitney test (table 2).

Table 2 *comparison of the physical fitness test and anthropometric data between injured and uninjured group by Mann-Whitney Test*

Variable	N		Mean		Standard Deviation		Median		P
	Injured	Uninjured	injured	uninjured	injured	uninjured	injured	uninjured	Value
50-Metre Swimming Test	126	319	41.49	43.10	8.69	10.17	40.00	42.00	0.1428
Pull-Up Test	140	355	8.40	8.75	3.25	3.15	9.00	9.00	0.5791
3000-Metre Running Test	140	355	842.75	841.51	69.84	78.59	841.00	831.00	0.4884
Push-Up Test	140	355	30.81	30.30	6.58	7.88	31.00	30.00	0.2581
Sit-Up Test	140	355	44.82	44.64	7.08	6.92	45.00	45.00	0.6941

Weight (Kg)	139	352	69.43	69.94	9.00	9.60	69.00	69.10	0.6011
Height (m)	139	352	1.76	1.76	0.07	0.07	1.76	1.76	0.8765
BMI (Kg/m^2)	139	352	22.39	22.50	2.33	2.46	22.22	22.38	0.4489

Using the univariate and multiple Cox regression to study the risk factors for musculoskeletal injuries, it was seen that the studied variables continued without statistical significance (table 3). After using the *stepwise* process of variable selection, all of the variables continued with no significance at the 5% level.

Table 3 *univariate and multiple Cox regression results to the study of risk factors for musculoskeletal injury*

Variable	**p-value**
50-Metre Swimming Test	0.1859
Pull-Up Test	0.3541
3000 Metre Running Test	0.8896
Push-Up Test	0.5625
Sit-Up Test	0.8215
Weight (Kg)	0.6481
Height (m)	0.8472
BMI (Kg/m^2)	0.6976

Because MTSS was the most prevalent musculoskeletal injury observed, we compared the data from MTSS-diagnosed subjects with the data from the uninjured group. A Mann-Whitney test was used for this comparison. Two anthropometric variables, weight and BMI, were significantly different between the two groups. The MTSS-diagnosed group had substantially lower weight and BMI than the uninjured group. There were no differences in the other studied variables (table 4).

Table 4 *Comparison of the variables between MTSS diagnosed group and uninjured group using the Mann-Whitney Test*

Variable	**N**		**Mean**		**Standard Deviation**		**Median**		**P**
	MTSS	**Uninjured**	**MTSS**	**Uninjured**	**MTSS**	**Uninjured**	**MTSS**	**Uninjured**	**Value**
50-Metre Swimmmg	29	319	40.48	43.10	6.63	10.17	40.00	42.00	0.3148
Pull-Up Test	33	355	8.76	8.75	2.75	3.15	9.00	9.00	0.6582
3000-Metre Running	33	355	819.45	841.51	75.22	78.59	820.00	831.00	0.1817
Push-Up Test	33	355	30.82	30.30	4.99	7.88	30.00	30.00	0.5252
Sit-Up Test	34	355	45.27	44.64	6.06	6.92	45.00	45.00	0.5747
Weight (Kg)	34	352	65.30	69.94	6.72	9.60	66.40	69.10	**0.0062**
Height (m)	34	352	1.75	1.76	0.05	0.07	1.76	1.76	0.6273
BMI (Kg/m^2)	34	352	21.26	22.50	1.84	2.46	21.50	22.38	**0.0023**

A univariate and multiple Cox regression was also applied to study the risk factors for the development of MTSS. It was seen that BMI and weight continued to be significant, demonstrating that low BMI and low weight are risk factors for the development of this overload injury (table 5).

Table 5 *Univariate and multiple Cox regression results in the s*

Variable	**p-value**
Athlete or not	0.2769
Weight (Kg)	**0.0086**
Height (m)	0.4599
BMI (Kg/m^2)	**0.0065**
50-Metre Swimming Test	0.1876
Pull-Up Test	0.9850
3000-Metre Running Test	0.1398
Push-Up Test	0.7224
Sit-Up Test	0.6245

When the variables above were selected using the *stepwise* process, only BMI continued to be significant at the 5% level (p-value=0.0092), which means that a smaller BMI is associated with a greater risk for MTSS.

The following table refers to the life quality of the injured participants measured using the SF-36 at the beginning of physiotherapy treatment and 30 days after the treatment was started. There was significant improvement in the following life quality aspects thirty days after the treatment had begun: functional capacity, physical aspect, pain, vitality, social aspect and mental health. The general state and emotional aspect did not change significantly in the second questionnaire (table 6).

Table 6 *SF-36 life quality analysis in the injured subjects before the treatment and 30 days after the treatment was started*

Evaluated variable	**N**	**Pontuation mean**	**Standard deviation**	**Median**	**p-value**
Initial functional capacity	139	71.31	24.17	75.00	
Final functional capacity	139	91.81	13.23	95.00	
Diference	0	20.50	23.50	15.00	<0.0001
Initial physical aspect	138	37.14	37.88	25.00	
Final physical aspect	138	63.22	40.77	75.00	
Diference	0	26.09	46.98	25.00	<0.0001
Initial pain	139	46.08	18.42	41.00	
Final pain	139	67.31	24.29	72.00	
Diference	0	21.23	27.69	21.00	<0.0001
Initial general state	139	81.32	14.47	82.00	
Final general state	139	81.63	16.59	87.00	
Diference	0	0.30	10.94	0.00	0.2631
Initial vitality	139	68.73	14.66	70.00	
Final vitality	139	71.44	14.52	75.00	
Diference	0	2.71	11.51	0.00	0.0028
Initial cocial aspect	139	82.19	19.96	87.50	
Final social aspect	139	87.41	17.39	100.00	
Diference	0	5.22	21.49	0.00	0.0058
Initial emotional aspect	139	83.57	29.69	100.00	
Final emocional aspect	139	84.65	30.63	100.00	
Diference	0	1.08	32.37	0.00	0.7801
Initial mental health	139	78.56	14.94	80.00	
Final mental health	139	81.49	13.34	84.00	

DISCUSSION

Although musculoskeletal injuries are commonly found among personnel engaged in military physical training, no previous studies were found in Brazil that developed an epidemiological investigation observing the prevalence of such injuries and analysing the risk factors and life quality in injured military personnel. Therefore, our study was the first study in the country to use this investigation model. Similarly, no studies were found that used this model in Latin America.

In the current study, like others in the literature (RAISSI et. al., 2009, VALIMAKI et. al., 2005), it was performed initial measurements and prospectively observed the prevalence of injuries. It was observed in our study that 28% of the analysed population, composed of 498 military students, presented a musculoskeletal injury and needed to be referred to the physiotherapy service.

In the injured group in our investigation, 62% had overload injuries, while 38% had traumatic injuries. The overload and traumatic classifications were previously adopted by some studies using the following definitions: “overload” is defined as a gradual establishment of the injury without a known trauma, and “traumatic” is defined as an abruptly developed injury with a known trauma (KNAPIK et. al., 2004).

The higher prevalence of overload injuries in military training was well-documented in previous investigations in different countries. A study developed to investigate Finnish military personnel observed that 66% of the injured participants had overload injuries, while 34% had traumatic injuries (TAANILA et. al., 2009). Another investigation studied 805 Chinese military personnel over a one-year period and observed that 77% of the musculoskeletal injuries developed in the population were overload injuries (WANG et. al., 2003). Consequently as observed in our investigation, there is an agreement in the literature that overload injuries are more frequent than are traumatic injuries in military training.

In relation to the anthropometric and performance variables, our study found that none of them were risk factors to the musculoskeletal injuries in general. On the contrary, another study prospectively observed that low physical fitness, as measured by a running test, was one of the risk factors associated with premature discharge from the Finish military service. This finding led the authors to the conclusion that subjects with low aerobic physical fitness probably suffer from more physiological stress during military training and also that fatigue in the unprepared subjects produces some changes in the lower limb cinematic and cause stresses and injuries in different musculoskeletal areas (TAANILA et. al., 2011, TAANILA et. al., 2010).

Conversely, a study with Greek military personnel observed that most diagnosed injuries occurred during the first and second weeks of the training programme, and the rates gradually fell until the last week, which was the seventh week. The authors of this study also suggested that apart from other factors, the injuries observed during the initial weeks of the programme could be related to deficiencies in physical fitness (HAVENETIDIS et. al., 2011). This conclusion was corroborated by others (HOOTMAN et. al., 2007). However, the association between poorer physical fitness and musculoskeletal injuries remains controversial. Our experimental study showed results contrary to some of the statements discussed previously. The initial performance and anthropometric characteristics of the group who developed any musculoskeletal injury was not different from the uninjured group.

This lack in complete knowledge of the risk factors for musculoskeletal injuries in general is expressed in some reviews, as the one by Murphy *et. al.*, 2003, who found five studies appointing an association between poor physical fitness and injury occurrence and two studies in which this association was not observed. The same authors also found that anthropometric variables were appointed as risk factors for lower limb injuries in five studies, while nine did not find this association (MURPHY et. al., 2003). The reasons that justify this controversy can be related to the fact that many different methods were used in the studies to categorise and assess the physical fitness and anthropometric profile, which makes comparison of the results difficult and also suggests that new investigations, as developed in our study, are still needed.

The most prevalent injury observed in our study was MTSS. MTSS was seen in 24.1% of the injured subjects. This prevalence rate was higher than the rate appointed by another author who states, based on a review, that the MTSS rates range from 6% to 16% of all running-related injuries (CRAIG, 2008).

To diagnose MTSS, we adopted the same criterion used in other studies in which MTSS was diagnosed as exertional pain on the tibial posteromedial side without any history of neurovascular symptom and associated with painful palpation of the area (RAISSI et. al., 2009, PLISKY et. al., 2007, GALBRAITH e LAVALLEE, 2009).

In our study, low body weight and low BMI were associated with MTSS. It was demonstrated that the lower the BMI, the higher the risk for MTSS. The performance variables were not associated with this overload injury.

There are few experimental studies available that have investigated the risk factors for MTSS. In contrast to our findings, a study observed that cross-country runner students presenting higher BMI were at increased risk for MTSS (PLISKY et. al., 2007). However, aside from the fact that they investigated a non-military population, this study showed several limitations. This study had a smaller sample, composed only of 59 male runners, and the subjects' BMI was obtained based on weight and height values provided by the participants in questionnaires.

Another prospective study, developed in an Australian Military Academy, sought to identify the risk factors for medial tibial pain. Similar to our study, it was observed that the level of aerobic fitness, as estimated by a running test at the beginning of the military service, was not different between the symptomatic and asymptomatic groups. The same finding was made when the BMI was considered. The groups with and without a history of pain in the medial tibial area had similar values of BMI, differing from our findings in this regard (BURNE et. al., 2004).

The Chinese study developed with 805 military personnel observed for one year showed that low BMI was a risk factor for overload injuries. However, although MTSS is an overload injury, that study did not specifically investigate the risk factors for MTSS (WANG et. al., 2003).

Interestingly, the BMI mean for the subjects in our study has been observed as lower than the BMI mean of subjects who were investigated in previous studies. Another research concluded that military personnel with lower and higher BMI than the mean of the population had more risk of the development of injuries related to physical training. However, this study was not specific to MTSS and also investigated a population with a higher BMI mean than those observed by us (JONES et. al., 1993). Likewise, several other studies showed a higher BMI mean compared to our findings (POPOVICH et. al., 2000, TAANILA et. al., 2011, BURNE et. al., 2004) which possibly can recommend future investigations regarding anthropometric differences in several populations.

Regarding the injured subjects' quality of life, we observed impairment of many variables at the beginning of physical therapy treatment. After thirty days, significant improvement was seen in almost all of the variables, except for general state and emotional aspect.

A study concerning the incidence of sports-related injuries in the Netherlands criticises the current registration and surveillance systems and the authors claim that these systems do not provide options to record sports-related injuries and their severity. Consequently, they conclude that little information is available about the impairments caused by musculoskeletal and sports injuries (BAARVELD et. al., 2011). In this context, the subjective perception of life quality measured by questionnaires as done in our study can be an option for the registration of such relevant information.

Our study had several strengths related primarily to its sample size. Almost 500 military students were included and observed through their studying and training year. Another positive aspect is the fact that the military atmosphere provides reasonably standardised conditions. Considering that the subjects were living in an internal regime, the military training routine, eating and rest were somewhat equal for all of the subjects, which supports the reliability of the results.

Clearly, the presented findings can be useful for future research developed in different populations, not only in the United States and Nordic European Countries, where these studies are commonly performed.

FINAL CONSIDERATIONS

Considering the variability of the results presented by the current literature and also taking into consideration the fact that the available studies have used many different methods to measure the variables and have observed different populations in different countries, new investigations would be desirable to define better the aetiology of military training injuries and the aetiology of MTSS and the quality of life of injured military personnel. In this context, the presented results are useful because we studied a previously uninvestigated population, thereby providing important information for future investigations.

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