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Prevalence of Musculoskeletal Symptoms Among Brazilian Merchant Navy Cadets: Differences Between Sexes and School Years

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ABSTRACT Background: Musculoskeletal disorders are common among military personnel, especially during the initial basic training period. Prior studies have reported the prevalence rate of overall musculoskeletal symptoms or injuries in different military population and nationalities, especially from North America and Europe; however, very limited information regarding the military population of South America exists. Although Brazil has one of the biggest military forces worldwide (≈335,000 military personnel), currently, to our knowledge, there is no study reporting musculoskeletal symptoms or injury statistics in the Brazilian Armed Forces. Thus, the aims of this study were to describe the 12-month prevalence rate of self-reported musculoskeletal symptoms in cadets and to compare this prevalence rate between sexes and school years. Methods: We conducted a cross-sectional study that took place from January to March 2016. Participants were Navy cadets, of both sexes and from three different school years of a Brazilian Merchant Navy Academy. All volunteers completed an adapted version of the Brazilian Nordic Musculoskeletal Questionnaire that assessed the past 12-month prevalence of musculoskeletal symptoms over eight body regions of the trunk and lower extremity. The Pearson's χ^2 test was conducted to compare prevalence of symptoms per body region between sexes and among the 3 school years. The study has been approved by the Naval Hospital's ethical committee. Results: A total of 545 cadets (394 males), corresponding to 79% of all 688 cadets enrolled at the Merchant Navy Academy, volunteered to participate on this study. Among all cadets, 266 (49%) reported symptoms in at least one body region in the past 12-months. The knee with 116 (21%) and lower back with 96 (18%), were the most prevalent regions. In terms of sex differences, there was higher prevalence of symptoms among females 90 (60%) than males 176 (45%). Furthermore, females reported almost double the prevalence for lower back symptoms (27% vs. 14%, p = 0.001) and 11% higher prevalence of knee symptoms (29% vs. 18%, p = 0.006) than males. Finally, it is important to highlight that cadets from the second (127 [65%]) and third (77 [55%]) school years had higher prevalence of symptoms than cadets from the first year (62 [29%]). The knee and lower back were consistently the two most prevalent regions among all school years, but shin symptoms increased from 3% to 17% ($p < 0.001$) between the first and second school years. Conclusion: The prevalence of musculoskeletal symptoms in the Brazilian Merchant Navy Academy doubles between initial enrollment and the beginning of the second school year. Females have consistently higher rates of symptoms than males, particularly reporting higher prevalence of knee and lower back pain which are the two most prevalent regions in this population. Prevention efforts should concentrate on the basic training period in an attempt to decrease the prevalence of musculoskeletal symptoms in this population. Finally, prospective studies are required to verify the cause and effect relationship between training and musculoskeletal symptoms.

INTRODUCTION

Musculoskeletal injuries have a high incidence rate in military population and are one of the most common causes of loss of working days, increased risk of attrition from active duty, and costs associated with compensation claims.[1] It has been shown that 50% of a sample of 272 Swedish marines reported limitation in work capacity because of pain and musculoskeletal symptoms.[2] In the Brazilian Navy, anecdotal observations have suggested that attrition because of physical training is a major a concern especially among new cadets and recruits.

Generally, in the military, the lower extremities present the highest prevalence of musculoskeletal pain (51% to 61%),[2,3] followed by the lower back (36%)[2] and within the lower extremities, the knee (17%), foot (16%), shin (≈17%), and ankle (9%) are usually the most common areas of self-reported musculoskeletal pain.[3,4] Because of the intense

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nature of military training, military personnel is at risk to report high rates of musculoskeletal symptoms[5–7]; however, during basic military training the risk is increased, as the cadets usually come from the civilian life and frequently have low levels of physical fitness to sustain the course's physical demand.[3,4,8,9]

Previous studies have reported the prevalence rate of overall musculoskeletal symptoms or injuries in different military population and nationalities. In a U.S. operative military cohort, musculoskeletal injuries prevalence rate ranged from 49% to 86% and the main causes of injury were attributed to running, marching with packs, and heavy occupational activities.[10] Similarly, during their initial entry training, 58% of U.S. Army recruits sustained at least one new injury, with physical training and road marching as main causes.[11] In European countries the prevalence of injury is similar; for instance, 28% of Greek Army cadets sustained an injury during a 7 week basic combat training,[12] whereas 58% of British Army infantry soldiers sustained an injury during a predeployment training cycle, mainly as a result of physical and military training activities.[13]

None of these studies had females in their cohort, which hinders the understanding of the real burden of musculoskeletal symptoms and injury in female military. However, one study that assessed females during a basic combat training course reported similar anatomic distribution of injuries between males and females, but an overall higher rate of injury in females (58%) than males (31%).[8] Similarly, a study conducted to evaluate male and female soldiers during an initial entry training, reported that 70% of all females presented injury-related physical restrictions compared to 30% of males.[4]

Clearly, the large majority of the musculoskeletal symptoms or injuries studies in the military were conducted in North America and Europe[2,5,13–18] and focusing mainly on males[10–13] with limited information regarding the military population of South America and female military personnel. Although Brazil has one of the largest military forces worldwide (≈335,000 military personnel),[19] currently, to our knowledge, there is no study reporting musculoskeletal symptoms or injury statistics in the Brazilian Armed Forces.

As military training varies between countries, it is essential to assess the prevalence of musculoskeletal symptoms within each country with a large military population and focus efforts for prevention and treatment on the body regions with highest prevalence and on the training periods that demonstrate the highest increases in symptom reporting. Also, to our knowledge, this is the first study to compare the prevalence of musculoskeletal symptoms among 3 different school years within the same Military Academy. Thus, the aims of this study were to describe the 12-month prevalence of self-reported musculoskeletal symptoms in cadets from a Brazilian Merchant Navy Academy and to compare prevalence rate between sexes and school years.

METHODS

Study Design and Participants

This was a cross-sectional study that is part of a larger prospective study of injury prediction. Participants were cadets, of both sexes from 3 different school years of a Brazilian Merchant Navy Academy. They were invited to participate in this study at the beginning of their academic year (January starting month for the first year or March for the second and third years) 2016. The Brazilian Merchant Navy Academy is managed by the Brazilian Military Navy; it has 3 academic years and all cadets are considered military personnel ranked as corporal. All cadets are volunteers and selected via public examination consisting of academic subjects (i.e., physics, math, chemistry) and a physical fitness test (running and swimming). They have a strict academic, military, and boarding routine, being allowed to leave the base only on weekends. To graduate from the Academy, all cadets must complete all 3 years of study, whereas the first year is the most physically demanding, as freshman cadets can only run (not allowed to walk) while moving around the base and they participate in intensive drill exercises. Finally, regardless of the school year, all cadets must participate daily in a 2-hour physical activity, such as running or swimming training sessions.

It is important to highlight that at the beginning of 2016, the first school year was composed by freshmen cadets (former civilians), whereas the second and third school year's cadets were the former first and second year in 2015, respectively. Thus, the 12-month prevalence of symptoms, for the first school year cadets includes the last year of civilian life, for the second year cadets includes the year between enrolment and the beginning of the second year and so on.

The inclusion criteria were participants older than 18 years of age, with no current complaint of lower extremity pain, spine pain, and medical or neuromusculoskeletal disorders that limited participation in the prospective study. Exclusion criteria: Participants were excluded if they were currently seeking medical care for lower extremity injuries or have had any surgery in the lower extremities in the past 12 months. The study has been approved by the Naval Hospital's ethical committee.

Data Collection

The participants completed a questionnaire consisting of demographics, smoking habits, alcohol consumption, sleep quality, lower extremity, and lower back symptoms history, and whether they have previously participated in strength training programs. As the prospective study purpose was to assess the lower extremity and lower back regions only, an adapted version of the Brazilian Nordic Musculoskeletal Questionnaire (NMQ)[20] comprised of two dichotomous answers ("yes"/"no") for eight anatomical areas (lower back, hip, thigh, knee, shin, calf, ankle, and foot) was included into this general questionnaire. The NMQ was chosen as it quantifies musculoskeletal pain or discomfort in different body regions and it is commonly used to assess musculoskeletal symptoms in an ergonomic or occupational health context.[20] Furthermore, it is a valid, reliable instrument (k = 0.88 – 1.00)[20] and it can be used in different study designs as well as administered via self-completion or personal interview.[21] Considering the cross-cultural adaptation requirements, the questionnaire is translated and validated to Brazilian Portuguese which allow for the musculoskeletal symptoms assessment. Furthermore, it has been extensively used to assess musculoskeletal symptoms prevalence in different Brazilian population[22,23] and military cohorts worldwide.[18,24] Although the NMQ is one of the most common questionnaires used to assess musculoskeletal symptoms in research,[25,26] it has some limitations and previous studies have therefore adapted its original version to the specifics of their studies population.[2,18,27] In this study, the NMQ was adapted to separate the hip and thigh, as well as the ankle and foot as these regions are combined in the original questionnaire. Furthermore, we simply added the shin and calf regions that do not exist in the original tool, but are commonly affected body regions in the military population.

Statistical Analysis

IBM SPSS Statistics 20 for Windows (IBM Corporation, Armonk, New York) was used for the statistical analysis and the level of significance was set at 0.05. Descriptive statistics are reported, stratified by sex and school year, as well as the overall prevalence rate of each body region (lower back, hip, thigh, knee, shin, calf, ankle, and foot) and the total prevalence for symptoms in at least one body region (at least one "yes" response for any body region). The Pearson's χ^2 test was conducted to compare prevalence of symptoms per body region between sexes and among the 3 school years. If there was an overall statistically significant difference among school years, a "post hoc" test was conducted to confirm where this difference occurred. So, the Bonferroni-adjusted p value was applied in accordance with the numbers of comparisons (first vs. second, first vs. third, and second vs. third school years at $\alpha = 0.05/3 = 0.017$).

RESULTS

Participant Characteristics

A total of 545 cadets (394 males and 151 females), corresponding to 79% of 688 cadets of the Academy participated in this study. From the first, second, and third school years, 211 (88% of 240), 195 (86% of 226), and 139 (62% of 222) cadets participated, respectively (Fig. 1). Participant characteristics and anthropometrics measurements are presented in Table I.

Overall Description of Self-Reported Symptoms

A total of 266 (49%) of 545 cadets reported symptoms in at least one lower extremity or lower back region in the past 12-months. The regions with the highest prevalence were the knee (21%) and lower back (18%), Table II. It was not possible to run the Pearson's χ^2 test for each body region individually as the assumption of having expected counts greater than 5 could not be met for some of them. So, all

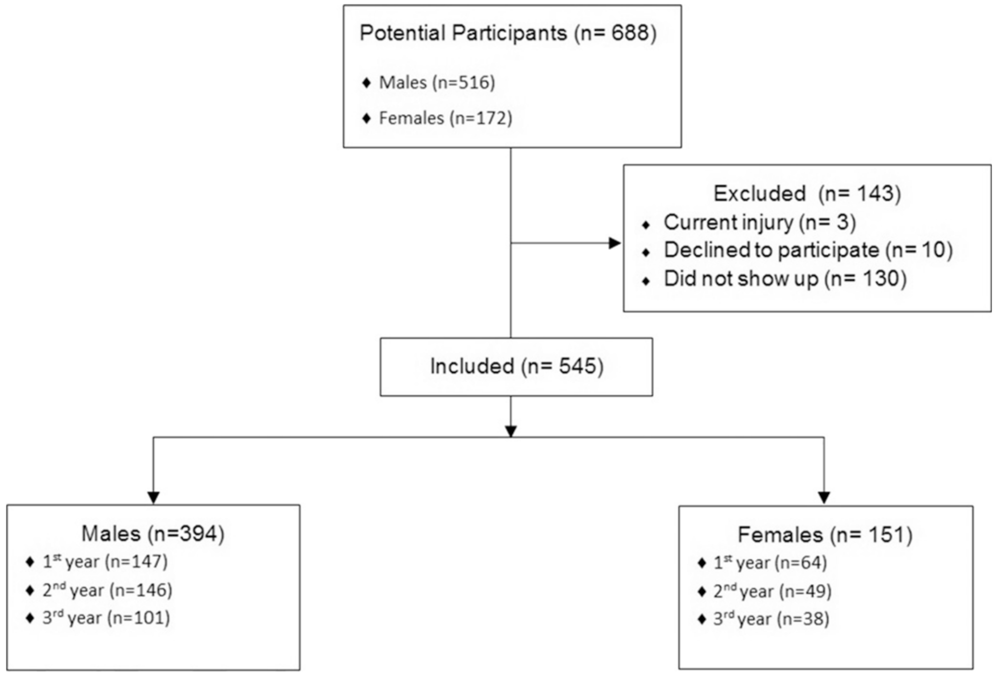

FIGURE 1. Flow of the participant's recruitment and inclusion.

TABLE I. Participant's Characteristics and Anthropometrics Measurements (mean ± SD)

	First year		Second year		Third year		All Years Combined	
	M	F	M	F	M	F	M	F
	(*n* = 147)	(*n* = 64)	(*n* = 146)	(*n* = 49)	(*n* = 101)	(*n* = 38)	(*n* = 394)	(*n* = 151)
Age (year)	20 ± 2	20 ± 1	21 ± 2	21 ± 1.4	22 ± 2	22 ± 2	21 ± 2	21 ± 2
Weight (kg)	73 ± 12	60 ± 7	75 ± 12	63 ± 9	79 ± 13	61 ± 9	75 ± 12	61 ± 8
Height (m)	1.74 ± 0.07	1.62 ± 0.05	1.75 ± 0.06	1.61 ± 0.05	1.77 ± 0.07	1.63 ± 0.07	1.75 ± 0.07	1.62 ± 0.05
BMI (kg/m^2)	24 ± 2	23 ± 2	25 ± 3	24 ± 3	25 ± 4	23 ± 3	25 ± 3	23 ± 3

SD, standard deviation; M, male; F, female; BMI, body mass index.

comparisons report on the overall prevalence of symptoms in at least one region and separately for some body regions with the highest prevalence.

Differences Between Sexes

Considering the prevalence of symptoms in at least one region across all school years, females demonstrated higher prevalence than males (60% vs. 45%, $p = 0.002$). Looking further into the most prevalent regions, females reported almost double the prevalence for lower back symptoms (27% vs. 14%, $p = 0.001$) and 11% higher prevalence of knee symptoms (29% vs. 18%, $p = 0.006$) than males.

Differences Among School Years

There was a statistically significant difference among school years for prevalence of symptoms in at least one region ($p < 0.001$). A "post hoc" analysis revealed that the second and third school years had higher prevalence in comparison to the first school year (65% vs. 29% and 55% vs. 29%, $p < 0.001$, respectively).

The knee and lower back were consistently the two most prevalent regions among all school years, but it is important to highlight the increase in shin symptoms between the first and second school years from 3% to 17% ($p < 0.001$).

DISCUSSION

Several important findings emerged from this study: (a) a large number of cadets (49%) reported symptoms in at least one lower extremity or lower back region in the past 12-month; (b) females presented higher prevalence of symptoms than males, mainly consisting of knee and lower back symptoms; (c) a significant increase of musculoskeletal symptoms occurred between initial enrolment and the beginning of the second year which was maintained as cadets entered their third year.

A previous study that evaluated U.S. soldiers initiating the basic combat medic course, reported that 43% of participants had musculoskeletal symptoms with the knee being the most prevalent body region (17%).[3] Although this study included upper extremities, those regions represented only 7% of the total symptoms, whereas lower extremities and trunk (back, ribs, and neck) represented 58% and 9%, respectively. Similar to our findings, one study of European soldiers starting their basic military training identified that 33% reported at least one musculoskeletal symptom over the

TABLE II. Prevalence of Self-Reported Musculoskeletal Symptoms in the Last 12 Months per Sex and School Year (*n* and %)

	Lower Back	Hip	Thigh	Knee	Shin	Calf	Ankle	Foot	Symptoms in at Least 1 of the 8 Regions
First Year									
Male (*n* = 147)	10 (7)	1 (1)	3 (2)	16 (11)	4 (3)	4 (3)	6 (4)	6 (4)	35 (24)
Female (*n* = 64)	9 (14)	1 (2)	3 (5)	13 (20)	3 (5)	4 (6)	8 (13)	4 (6)	27 (42)
Total (*n* = 211)	19 (9)	2 (1)	6 (3)	29 (14)	7 (3)†	8 (4)	14 (7)	10 (5)	62 (29)‡¶
Second Year									
Male (*n* = 146)	33 (23)	4 (3)	7 (5)	36 (25)	24 (16)	13 (9)	17 (12)	18 (12)	89 (61)
Female (*n* = 49)	19 (39)	2 (4.1)	7 (14)	21 (43)	9 (18)	6 (12)	3 (6)	6 (12)	38 (78)
Total (*n* = 195)	52 (27)	6 (3)	14 (7)	57 (29)	33 (17)†	19 (10)	20 (10)	24 (12)	127 (65)‡
Third Year									
Male (*n* = 101)	13 (13)	1 (1)	5 (5)	20 (20)	8 (8)	5 (5)	16 (16)	9 (9)	52 (52)
Female (*n* = 38)	12 (32)	1 (3)	1 (3)	10 (26)	6 (16)	6 (16)	5 (13)	6 (16)	25 (66)
Total (*n* = 139)	25 (18)	2 (1)	6 (4)	30 (22)	14 (10)	11 (8)	21 (15)	15 (11)	77 (55)¶
All Years									
Male (*n* = 394)	56 (14)*	6 (2)	15 (4)	72 (18)**	36 (9)	22 (6)	39 (10)	33 (8)	176 (45)***
Female (*n* = 151)	40 (27)*	4 (3)	11 (7)	44 (29)**	18 (12)	16 (11)	16 (11)	16 (11)	90 (60)***
Total (*n* = 545)	96 (18)	10 (2)	26 (5)	116 (21)	54 (10)	38 (7)	55 (10)	49 (9)	266 (49)

Differences between sex per school year: **$p = 0.006$; ***$p = 0.002$; *$p = 0.001$. Differences among school years: †‡¶$p < 0.001$.

past 6 months. Moreover, the lower back (20%) and the knee (18%) were also the two most prevalent. Overall, the Brazilian Navy cadets presented similar regions of musculoskeletal symptom prevalence to the U.S. military and higher than some European countries; but, direct comparisons are difficult as those symptoms may vary in accordance to the type of military specialty or population assessed.

Regarding sex differences, it has been demonstrated that females have higher risk to sustain a musculoskeletal injury than males, whether in sports or during military activities.[8,28] Similar findings were previously described concerning self-reported musculoskeletal symptoms, where females in military presented increased prevalence rates than males.[3,4,18] In our sample, this outcome was also confirmed, as female cadets presented higher prevalence of overall symptoms. Some sex differences, such as lower muscle strength[16] may justify this increased prevalence rate in females as it has been shown that females have on average 12 kg less skeletal muscle mass than males.[29] Another explanation may be related to altered biomechanics during running, for instance increased knee valgus at initial contact, decreased knee flexion, and increased peak hip adduction and internal rotation that seems to be a common pattern associated with patellofemoral syndrome, anterior cruciate ligament injury, and medial tibial stress syndrome in females.[30]

As expected, the first school year presented the lowest prevalence rate of overall symptoms. It is important to highlight that we applied a questionnaire relative to their past 12-months, so cadets from the current second and third school years based their answers on the first and second school year, respectively. It has been suggested that an abrupt change in lifestyle when entering a military career can be physically and mentally challenging for new cadets, promoting the development of injuries and illness.[31] Therefore we can speculate that higher reported symptoms exhibited by the current second school year in comparison with the first school year may be the result of the fact that first year cadets are exposed to increased amount of running, marching, and drill exercises during the first month (adaptation period) as well as throughout the year while they still have lower fitness levels. Additionally, it is possible that drill exercises were responsible for the abrupt increase in shin symptoms between the first and second school years, as these activities can generate high forces and load in the lower extremities, because cadets are required to march by flexing their hip about 90° and to stamp their feet against the ground in an attempt to make noise.[32] It has been shown that military drill activities generate higher peak vertical impact force, peak vertical load rate, and peak tibial impact acceleration than running and load carriage.[32] This is important as there is evidence suggesting that increased vertical loading rates and tibial shock during impact activities, may increase the likelihood to develop lower extremity stress fracture.[33,34] Even though the hard impact is promoted during drills to produce a psychological effect of team work, military trainers may consider using different strategies that are safer for the musculoskeletal system and a longer more gradual adaptation period.

STRENGTHS AND LIMITATIONS

This study has several strengths, as a substantial number of females were included in the sample, as most of studies with military personnel have been done only or predominantly in males. Furthermore, there was a low risk of selection bias because a large majority of the Brazilian Merchant Navy Academy (79% of all cadets) participated.

Limitations include the use of a retrospective self-reported musculoskeletal symptoms questionnaire, raising the possibility of recall bias. Moreover, although most of the time injuries are associated with pain and discomfort, we cannot affirm that self-reported musculoskeletal symptoms are directly related to injury and its severity. Besides that, as a cross-sectional study design, it is not possible to infer a cause and effect relationship among our findings.

CONCLUSION

The prevalence of musculoskeletal symptoms in the Merchant Navy Academy doubles between initial enrolment and the beginning of the second year. Females have consistently higher rates of symptoms than males, particularly reporting higher prevalence of knee and lower back pain which are the two most prevalent regions in this population. Prevention efforts should concentrate on the basic training period.

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