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Musculoskeletal injuries and the level of somatic constitution and physical fitness of officer cadets at the Military Academy of Land Forces

Dariusz LENART

General Tadeusz Kościuszko Military Academy of Land Forces, Wrocław, Poland
Lt. Col. Dariusz LENART, PhD
109 Czajkowskiego Street
51-150 Wrocław
Poland
E-mail: d.lenart@wso.wroc.pl
Mobile phone: 886752126

Abstract

Purpose. The educational process requires a commitment from officer cadets to develop and maintain physical fitness as a basis for implementing various training tasks. This process is often associated with numerous overloads and musculoskeletal injuries in students. Therefore, the aim of the study was to assess whether injuries and overloads suffered during the training process at the Military Academy of Land Forces differentiated somatic constitution, physical fitness and functional parameters of the respiratory system in the officer cadets. **Methods.** The research material was gathered as a result of testing officer cadets of the Military Academy of Land Forces in Wrocław in 2011-2015. 89 men were covered by the study. The average age of the examined cadets was 22.9 years. Examinations of the students included anthropometric measurements, physical fitness tests, spirometry and a survey. **Results.** The results indicate the presence of significant differences in the somatic construction of the officer cadets. Similar physical fitness and the level of the respiratory system efficiency characterized separated groups of students in terms of suffered injuries. **Conclusions.** Previous injuries turned out to be a factor, which significantly differentiated somatic constitution of the officer cadets. The advantageous, from the health point of view, mean values of the body height, lean body mass, muscle mass and bone mass characterized

students, who during the four-year education at the military academy did not suffer musculoskeletal injuries. Past injuries were not also a factor, which substantially diversified the level of functional characteristics.

Keywords: musculoskeletal injuries, somatic construction, physical fitness

Introduction

Training of candidates for officers, especially candidates for sub-unit commanders, is an important area of training activities of the Polish Armed Forces. At the General Tadeusz Kościuszko Military Academy of Land Forces the process of training candidates for officers is realized at the Faculty of Management, the specialization 'Command of sub-unit'. Currently, the teaching load is 4293 hours within the three-year bachelor's degree studies, and 2086 hours at supplementary MA studies. The main objective of the military training of candidates for officers, graduates of secondary schools, is to prepare them to perform various tasks in positions of platoon leaders. Knowledge, a variety of skills, including methodological ones, and social competencies acquired in the educational process should provide them with the ability to solve organizational problems effectively and conduct tactical operations on the platoon level.

The process of education implemented at the Wroclaw Military Academy requires a commitment from officer cadets to develop and maintain physical fitness as a basis for implementing different training tasks. This process is often associated with numerous overloads and musculoskeletal injuries in students. However, day-to-day routine physical activity necessary to achieve and maintain the desired level of physical fitness may lead to overloads and musculoskeletal injuries related to the training [3]. The recent study conducted in the US Armed Forces revealed the relationship between training injuries and half of all deaths of soldiers, half of all disabilities and half of all soldiers' medical visits. According to the researchers, the training injuries in the US soldiers result in a longer time of their absence from service (from 5 to 22 days) than diseases do [4]. Many authors consider that the risk factors for training injuries are both external, e.g. the environment, military personnel activities, as well as internal, e.g. sex, age, the level of physical activity [4, 5, 6, 7].

The frequency and the type of training injuries differ significantly with respect to data from different countries. In the Scandinavian armies, e.g. in the Norwegian Armed Forces, the incidence of injury is higher compared to the US Armed Forces, and lower in comparison with the Israeli, the South African or the New Zealand Armed Forces [4, 8, 9].

The authors of most works taking up the issue of overloads and injuries of military students tend to base on research carried out in short periods of training, e.g. during the basic combat training or activities in the military training field [10, 11]. The number of publications discussing the issues of incidence of injuries and overloads of soldiers over a long period of training or education at military academies is negligible [12].

Therefore, the aim of the study was to assess whether injuries and overloads suffered during the educational process at the Military Academy of Land Forces differentiated somatic constitution, physical fitness and functional parameters of the respiratory system in the officer cadets. It was hypothesized that more the favourable somatic build, from a health point of view, and a higher level of physical fitness may be presented by students, who during the four-year education at the military academy did not suffer musculoskeletal injuries.

Material and methods

The research material was gathered as a result of tests conducted among officer cadets studying at the Military Academy of Land Forces in Wrocław, Faculty of Management, in 2011-2015. The study covered 89 men. The average age of the cadets was 22.9 years. Examinations of the students included anthropometric measurements, physical fitness tests and spirometry. The basic somatic characteristics, i.e. height and weight were measured. The body height was measured with the anthropometer with the accuracy of 0.1 cm, while the body weight – using medical scales with the accuracy of 0.1 kg. Then, the body mass index (BMI) was calculated on the basis of the height and weight measurements. The body composition was assessed based on the bioelectrical impedance by means of the body composition analyzer Tanita SC-330. The weight of body fat, lean body mass, muscle mass and bone mass were checked as well. The level of physical fitness was determined using the following motor test: run over a distance of 3000 m (cardio-respiratory endurance), bent arm hang (functional strength), shuttle run 10 x 5 m (speed and agility), Flamingo balance test (body balance).

The following respiratory abilities were also measured: forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC), peak expiratory flow (PEF). All the above measurements were made using the Pneumo RS spirometer with accuracy of 0.01 liters.

Measurements of the somatic characteristics as well as functional and respiratory abilities were carried out in sports facilities of the Military Academy of Land Forces. Officer cadets performed physical fitness tests in sports field uniforms, always in similar conditions.

The survey provided, among other things, the information about:

- types of injuries suffered by the cadets;

- periods during which the test participant suffered from injuries;
- percentage distribution of the cadets, who suffered injuries in various periods of education, with respect to their number;
- circumstances in which the men experienced injuries.

Statistica version 9.0 for Windows (StatSoft Inc., USA) was used for statistical analysis. The arithmetic mean, standard deviation and coefficient of variation were calculated, which were used to carry out the characteristics of the level of the selected somatic characteristics as well as functional and respiratory abilities of the subjects. The Shapiro-Wilk test was used to check the distribution of the examined variables for normal distribution. The *t* Student's test for independent samples was used, in order to determine statistically significant differences in the level of the selected morphological characteristics and physical abilities between separated groups of students in terms of suffered injuries. The level of significance = 0.05 (statistically significant differences were determined when $p < 0.05$).

Results

Out of the total number of the cadets the largest percentage (29.2%) are those, who did not suffer any injury over a four-year period of education, and the men who had joint injuries (23.6%). While the cadets who suffered orthopedic injuries during the training process at the Wrocław Military Academy constitute the lowest percentage of the respondents (2.2%) (Figure 1).

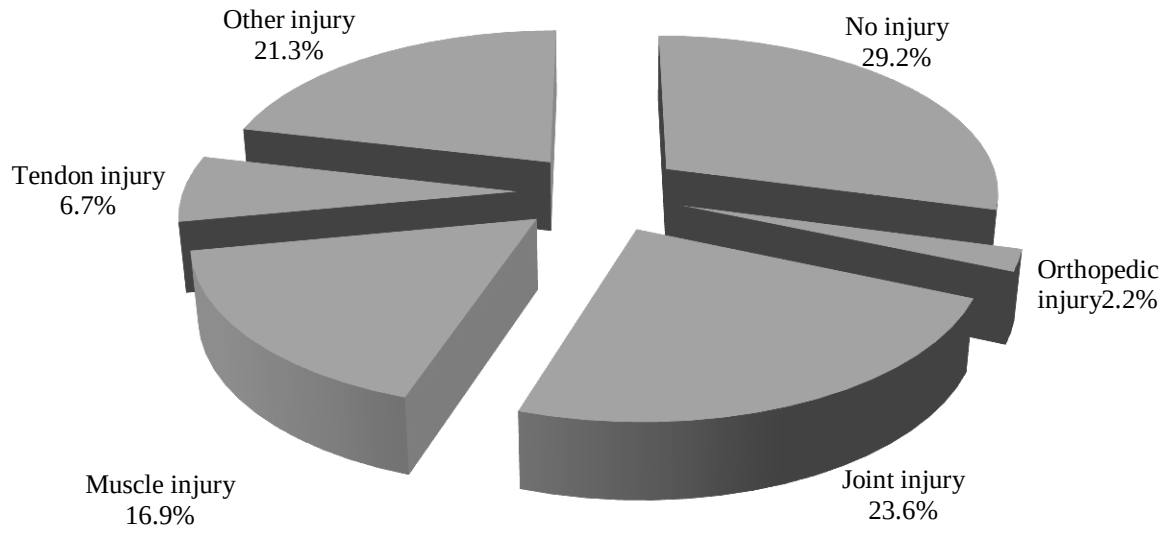

Figure 1. Percentage distribution of the cadets by the type of injury or its absence

The similar and at the same time the largest percentage of the men suffered the injury during the second, third and fourth year of study (22.2% each) of the study group (Figure 2).

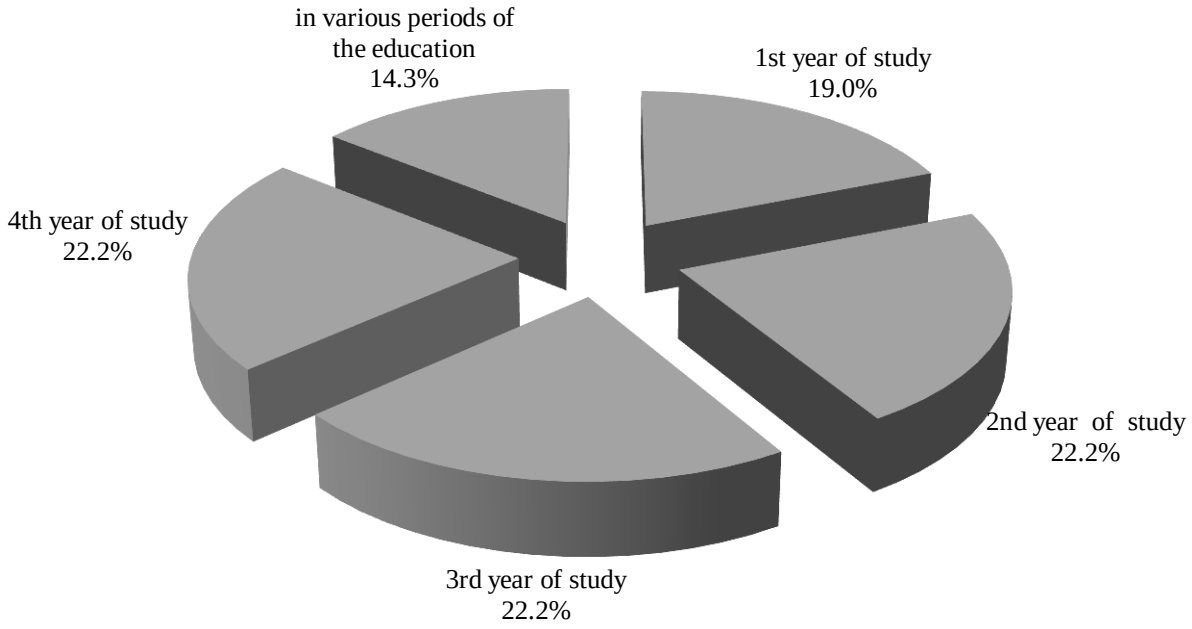

Figure 2. Percentage distribution of the cadets by the time of injury occurrence

Among those who suffered injuries at various stages of education the cadets with two injuries constitute the largest percentage (59.4%), while those with more than four injuries - the smallest one (Figure 3).

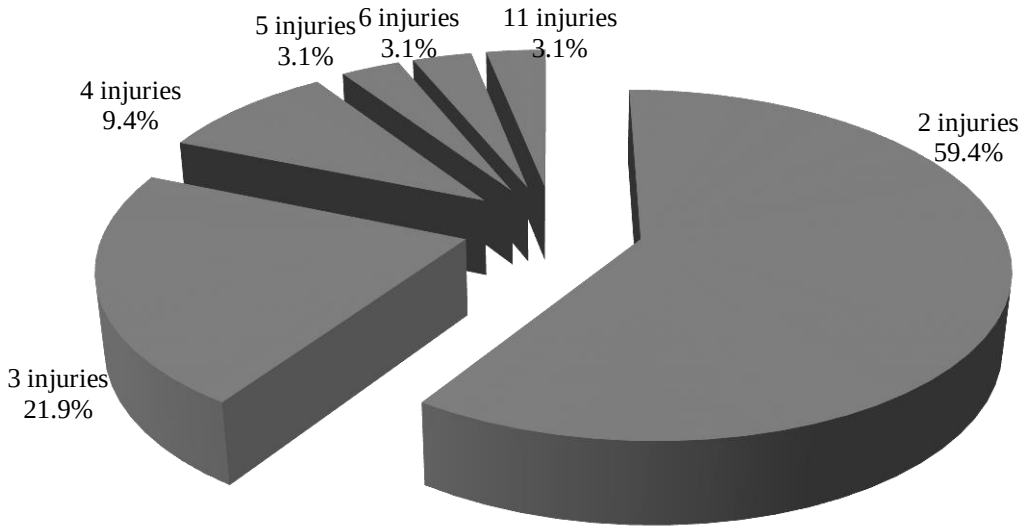

Figure 3. Percentage distribution of the cadets, who suffered injuries in various periods of education, with respect to their number

Of all the cadets, who had injuries while studying at the Military Academy of Land Forces, the largest is the group of those who suffered them during sports and health trainings, i.e. 38.1% (Figure 4). The smallest group of the respondents experienced the incidence of injury at the time of the morning physical trainings (4.8%) and under many circumstances (4.8%).

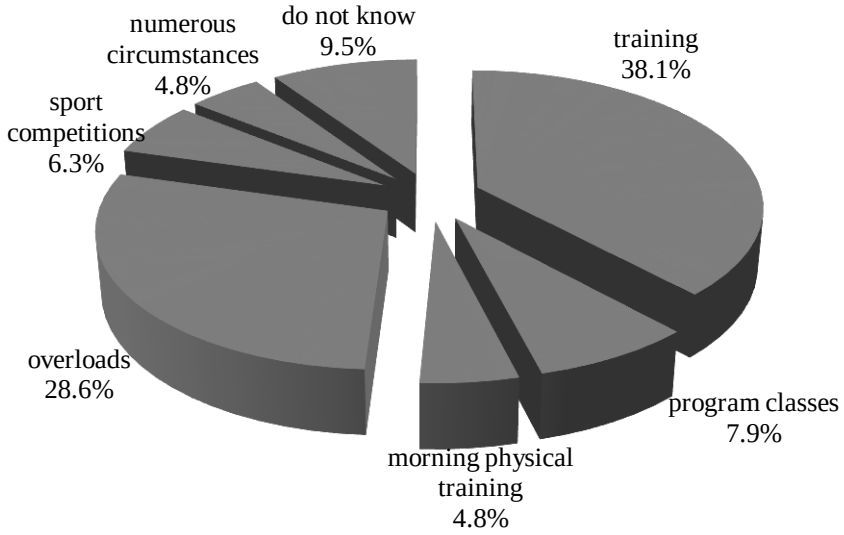

Figure 4. Percentage distribution of the cadets by circumstances of injury occurrence

The level of the analyzed somatic and functional features of the men tested is presented in Table 1.

Table 1. General characteristics of the examined officer cadets

Variable	Total number of cadets		
	M	SD	V
Body height [cm]	179.44	5.31	2.96
Body weight [kg]	78.66	8.38	10.65
Weight of body fat [kg]	13.17	3.74	28.40
Lean body mass [kg]	65.49	5.54	8.46
Muscle mass [kg]	62.23	5.29	8.50
Bone mass [kg]	3.25	0.25	7.69
BMI [kg/m^2]	24.52	2.11	8.61
Run over a distance of 3000 m [s]	742.73	42.83	5.77
Bent arm hang [s]	49.60	13.50	27.22
Shuttle run 10 x 5 m [s]	19.09	1.18	6.18
Flamingo balance test [number]	5.80	3.18	54.83
FEV_1 [l/s]	4.98	0.23	4.62
FVC [l]	6.08	0.26	4.28
PEF [l/s]	10.75	1.08	10.05

FEV_1 – forced expiratory volume in 1 second, FVC – forced vital capacity, PEF – peak expiratory flow

Table 2. The descriptive statistics of the selected somatic characteristics and functional and respiratory abilities of the examined officer cadets

Variable	Cadets without injuries during four-year education period N=26			Cadets with incidence of injuries during four-year education period N=63			t	p
	M	SD	V	M	SD	V		
Body height [cm]	181.84	5.21	2.87	178.45	5.06	2.84	2.85	**0.01**
Body weight [kg]	80.88	8.20	10.14	77.74	8.35	10.74	1.62	0.11
Weight of body fat [kg]	13.48	3.60	26.71	13.05	3.81	29.20	0.50	0.62
Lean body mass [kg]	67.40	5.55	8.23	64.70	5.38	8.32	2.14	**0.04**
Muscle mass [kg]	64.07	5.29	8.26	61.48	5.15	8.38	2.14	**0.03**
Bone mass [kg]	3.33	0.26	7.81	3.22	0.24	7.45	2.04	**0.04**
BMI [kg/m^2]	24.50	1.86	7.59	24.53	2.22	9.05	0.04	0.97
Run over a distance of 3000 m [s]	743.35	37.88	5.10	742.48	45.00	6.06	0.09	0.93
Bent arm hang [s]	46.69	10.39	22.25	50.79	14.50	28.55	1.31	0.19
Shuttle run 10 x 5 m [s]	18.85	1.13	5.99	18.75	1.07	5.71	0.41	0.68
Flamingo balance test [number]	6.77	3.64	53.77	5.40	2.91	53.89	1.88	0.06
FEV_1 [l/s]	4.96	0.23	4.64	4.98	0.23	4.62	0.38	0.71
FVC [l]	6.08	0.27	4.44	6.08	0.26	4.28	0.14	0.89
PEF [l/s]	10.62	1.07	10.08	10.80	1.08	10.00	0.71	0.48

FEV_1 – forced expiratory volume in 1 second, FVC – forced vital capacity, PEF – peak expiratory flow
the bold-face indicates the *t*-Student test values (when there is a statistically significant difference between intergroup mean values of a given trait) and *p* value (when $p < 0.05$)

Two teams of students separated depending on injuries or their absence are characterized by the differentiated somatic construction and the body composition. as evidenced by statistically significant differences in most of the analyzed somatic parameters (Table 2). The cadets who did not suffer any injury during the period of four years of training had the significantly more preferred, from the health point of view, body composition in comparison to those who experienced injuries. This is evidenced by their higher mean body height, lean body mass, muscle mass and bone mass. Only with respect to body weight, body fat mass and body mass index the cadets do not substantially differ significantly.

The results obtained by the separate groups of cadets clearly indicate the similar level of physical fitness and respiratory efficiency of the respondents (Table 2). The surprising fact is that despite the lack of statistically significant differences in the level of functional abilities and respiratory abilities, which are analyzed in the work, the military students who suffered injuries during their education at the Wrocław Military Academy were characterized by

slightly more favorable results. This fact may result from adequate rehabilitation treatment provided.

Discussion

Regular physical activity belongs to the most important determinants of human health. It has a positive impact on the human body only when is of appropriate amount, intensity and frequency. A risk to health grows in direct proportion to the load and intensity of physical activity; risks associated with excessive body overload applied during many years of military training are possible to appear. Too strenuous military training, like the training of athletes in competitive sports, should include the need to prevent the occurrence of adverse effects: overloads, injuries, diseases of various kind [12, 13, 14]. The improper use of loads leads to fatigue and overtraining as well as is connected with inadequate injury prevention [15].

Unfortunately, the occurrence of injuries is common in the modern military education; this is difficult to be avoided, even in the case when physical activity is undertaken only during program classes. The authors of most works taking up the issue of injuries in the course of the training process pay special attention to the high prevalence of injuries in the initial period, during the basic training [16, 17, 18]. According to Wyss et al., the average rate of injuries in soldiers of the Swiss Armed Forces in the training period is 18 injuries per 100 recruits a month [11]. In the opinion of the researchers of this matter, in other armies this ratio varies between 10 and 15 per 100 recruits a month [16, 17, 18].

The analysis of own research results, however, has not confirmed the findings of the abovementioned authors. Most musculoskeletal injuries of men occurred between the second and the fourth year of study (22.2% each year).

The soldiers' physical fitness and proper body composition can contribute to injuries and diseases, the causes of which are not associated with combat activities. According to Hartstein et al. [19], the soldiers who maintain a lower aerobic capacity are much more exposed to injuries. In many works the correlation between physical fitness of the military personnel or recruits and injuries arising from the service was revealed [20, 21]. Earlier studies proved that elevated levels of aerobic capacity, strength, endurance and agility reduces the risk of musculoskeletal injuries [20]. In addition, some studies showed that higher levels of activity and the cardiopulmonary efficiency reduce the incidence of diseases [20].

The analysis of the results obtained in own research confirmed the findings of many authors. The study showed that statistically significant differences between the cadets who suffered musculoskeletal injuries in the four-year education period and the group of students who did not experience any injuries in the teaching process exist only in body height, body

lean body mass. muscle mass and bone mass. There were no significant differences observed between the separated groups of respondents as far as physical fitness and the level of functional abilities of the respiratory system are concerned.

Conclusions

1. Musculoskeletal injuries in the educational process turned out to be the factor, which differentiates somatic construction and body composition of the examined cadets. There were no significant differences between the separated groups of men only in the case of body weight, fat mass and body mass index. Students who did not suffer any musculoskeletal injury during the four-year Military Academy education enjoyed more favorable, from the health point of view, average values of body height, lean body mass, muscle mass and bone mass.
2. The existing overloads and injuries did not differentiate physical fitness and the level of the discussed in the work functional abilities of respiratory system. However, it should be noted that the level of most functional abilities was higher, though slightly, in men, who experienced overloads and musculoskeletal injuries during several years of education.

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