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Effects of regular sport activities on stress level in sporting and non-sporting university students

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ABSTRACT

Background: Regular sport has favourable influence on the physical and mental state. Our aim was to analyse the relationship between regular sport activities, body parameters, cortisol level, perceived stress and the frequency of psychosomatic symptoms in male and female university students. *Methods:* Subjects were university students ($N = 200$). They were divided in sporting (more than 7 h week^{-1}: 56 males (sm), 50 females (sf)) and non-sporting (less than 3 h week^{-1}: 44 males (nsm) and 50 females (nsf)) groups. Body composition was estimated by Inbody720-analyser. Stress levels were measured by (1) free cortisol level in saliva measured by using IBL-ELISA kits and (2) questionnaires about psychosomatic symptoms and perceived stress scale. *Results:* There were significant subgroup' differences in body composition (fat%:sm:12.1 ± 6.0 vs. nsm:17.9 ± 6.8; sf:20.8 ± 5.5 vs. nsf:25.4 ± 5.7; muscle%:sm:50.3 ± 3.6 vs. nsm:47.6 ± 3.9; sf:43.8 ± 3.2 vs. nsf:41.7 ± 3.3), and in stress level (total scores:sm:21.0 ± 5.7 vs. nsm:23.3 ± 7.2; sf:25.5 ± 7.0 vs. nsf:28.0 ± 9.7). There were gender differences in the psychosomatic symptoms' frequency (total scores: sm: 14.6 ± 6.3 vs. sf: 20.4 ± 7.4; nsm: 14.9 ± 6.1 vs. nsf: 19.6 ± 8.2). The sporting students had larger muscle, smaller fat percentages, and lower level of stress. Basic level of salivary cortisol revealed significant relation with physical activity: sporting students had lower level of cortisol. This relation was reflected in higher percentage of students with low level of cortisol in the physically active

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subgroups (s/ns males: 29% vs. 15%; s/ns females: 18% vs. 5%) and in the higher percentage of female students with high level of cortisol in the non-sporting subgroup (27% vs. 11%). *Conclusion:* Regular sport activity is positively related with lower stress levels in university students.

INTRODUCTION

Increasing stress level has been observed in students at many universities (excessive expectations, exams, irregular lifestyles, foreign circumstances, lack of familiar company, etc.), and mental health issues pose significant problems for many college students [1–4]. Regular sport activity has favourable influence on the physical and mental state, and significantly enhances mental health and well-being also among university students whose average time spent sitting is approximately 7.5 h per day [5]. For significant health benefits, adults should do at least 150–300 min per week of moderate-intensity, or 75–150 min per week of vigorous-intensity aerobic physical activity (PA) [6].

University students' activity has been estimated by a number of methods (IPAQ – International Physical Activity Questionnaire or other questionnaires, different accelerometers, applications, etc.), however, most studies agree that only 40–60% of them achieve physical activity recommendations, so the sedentary lifestyle is a very worrying phenomenon that deserves attention in this young population [7, 8].

Cortisol level has been used as a biomarker of stress response in a multitude of psychological investigations [9, 10]. Salivary cortisol is a popular, non-invasive measurement tool for investigating hypothalamic-pituitary-adrenal axis (HPA) activity under normal conditions and in response to stress [11]. Despite its widespread use, little is known about whether lifestyle factors such as regular exercise and physical fitness are related to this salivary stress marker [12, 13].

Exercise serves as a stressor, and cortisol is a common biomarker that is used in the analysis of acute exercise responses in both athletes and non-athletes, but it is not very useful in examining the relationships between regular physical activity and stress levels, because simpler questionnaire methodologies are often used. However, currently, discrepancies are observed in the literature [9, 14] about the relationships of stress or cortisol level and sport activities. In addition, we have almost no knowledge of objective and subjective stress indicators according to the level of physical activity in students.

The aim of this study was to analyse the relationship between regular sport activities and body parameters to cortisol level, perceived stress and the frequency of psychosomatic symptoms in male and female university students.

MATERIALS AND METHODS

Participants

The subjects ($N = 200$, aged between 19 and 25 years, 22.75 ± 1.81 yrs) were sporting (sporting males: $n_{sm} = 56$, sporting females: $n_{sf} = 50$; more than 7 h sport activity per week – faculty of

physical education) and non-sporting university students (non-sporting males: $n_{nsm} = 44$, non-sporting females: $n_{nsf} = 50$; less than 3 h sport activity per week – faculty of biological sciences). On average, 25–30% of the lessons of university students in the faculty of physical education are sports practical education (10–12 h per week with personal physical activity), while biology students attend an average of one physical education class per week, and they have a predominantly sedentary activity in their university classes. Students from the faculty of physical education who did not meet the minimum 7 h of physical activity criterion in the month prior to the study due to injury, illness, or other reasons were excluded from the sporting group. Before investigations, all participants were asked to avoid caffeine, alcohol and exercise for 12 h, drinking, eating for 2 h. The study was conducted in accordance with the Declaration of Helsinki for Human Research. Students participated exclusively as volunteers from two universities. All participants received written information about the goal of the survey and the procedures. Written consent was given by each participant and was collected before the start of the investigation. Data management was conducted anonymously, the study' participants were provided with code numbers, and we only used these codes for further data recording and analysis.

Ethical approval was obtained from the ethical committee of the University of Physical Education, Hungary (ID: TE-KEB/No10/2018).

Procedures

Anthropometry. Anthropometric measurements were taken according to the International Biological Program [15]. The instruments were calibrated prior to use and all measurements were taken on the subjects' right side. Anthropometric variables, including body mass, body height, seven skinfolds (biceps, triceps, subscapular, suprailiac, abdominal, thigh, and medial calf), two bone widths (elbow and knee), and seven girths (chest, upper arm, lower arm, wrist, ankle, thigh, calf) were measured using the protocol of the International Society for the Advancement of Kinanthropometry (ISAK) [16].

Body height (BH) was measured with a stadiometer (model 214, Seca-Bodymorph, Birmingham, UK) to the nearest 0.1 cm, and body weight (BW) was recorded on a portable scale (model 707, Seca Corporation, Columbia, Maryland) to the nearest 0.1 kg. Skinfolds were measured with the use of a caliper (Harpenden CE0120, West Sussex, UK) to the nearest 0.2 mm. Widths were taken with a sliding caliper (Rosscraft), girths were measured with a flexible metallic tape (Lufkin W606PM) to the nearest 0.1 cm. All measurements were taken by skilled anthropologists (MSz, AZs). Each body size was measured three times, and averaged for further analysis. In case the difference between the multiple measurements exceeded 0.1 cm or 0.1 kg (body weight), the erroneous data was dropped out. Body mass index (BMI) was calculated by using body weight and height (kg m^{-2}). Relative fat mass (Fat%) estimation followed the procedure set out by Pařižková [17]:

$$Fat\%_{male} = 28.894 \times \log[2(biceps + triceps + subscapular + suprailiac + calf\ skinfolds)] - 41.18\ and$$

$$Fat\%_{female} = 39.572 \times \log[2(biceps + triceps + subscapular + suprailiac + calf\ skinfolds)] - 61.25.$$

Body composition was assessed with the Drinkwater and Ross technique [18]. Bone and muscle mass were determined based on the following equations:

$$\text{Bone mass(kg)} = [1.57 \times 0.25 \times (zb1 + zb2 + zb3 + zb4) + 10.49]/(hc^3)$$

$$\text{Muscle mass(kg)} = [2.99 \times 0.2 \times (zm1 + zm2 + zm3 + zm4 + zm5) + 25.55]/(hc^3)$$

$$zb1 = (\text{elbow width} \times hc - 6.48)/0.35; \quad zb2 = (\text{knee width} \times hc - 9.52)/0.48;$$

$$zb3 = (\text{wrist girth} \times hc - 16.35)/3.14/0.72; \quad zb4 = (\text{ankle girth} \times hc - 21.71)/3.14/1.33;$$

$$zm1 = [(\text{upper arm relaxed} - 0.314 \times \text{triceps skinfold}) \times hc - 22.05]/3.67;$$

$$zm2 = [(\text{chest girth} - 0.314 \times \text{subscapular skinfold}) \times hc - 82.36]/4.68;$$

$$zm3 = (\text{lower arm girth} \times hc - 25.13)/1.41;$$

$$zm4 = [(\text{thigh girth} - 0.314 \times \text{thigh skinfold}) \times hc - 44.34]/3.59;$$

$$zm5 = [(\text{calf girth} - 0.314 \times \text{calf skinfold}) \times hc - 30.22]/1.97;$$

$$hc = 170.18/\text{height}.$$

Bioelectrical impedance analysis. To assess abdominal obesity, the visceral fat area (VFA – cm^2) was also estimated by bioelectrical impedance analysis equipment (Inbody720 analyser) [19, 20]. Subjects stood in an anatomical position with their hands and feet on the electrodes, wearing light clothes and without metal accessories. This position was maintained until the evaluator finished the test. The impedance between the body segments was measured while an alternating current (1,5, 50, 250, 500, 1000 kHz) passed through the lower and upper body. Participants were informed in advance of the conditions that had to be sustained prior to measurement: no exhausting exercise for at least 12 h prior, no food or drink for at least 2 h prior, and urination immediately before the measurement.

Handgrip strength test. Handgrip strength is suitable for predicting total muscle strength and musculoskeletal fitness in young adults [21, 22]. Handgrip strength was measured with a standard handheld dynamometer (Electronic Hand Dynamometer Model: EH101 model with adjustable grip). Participants were asked to hold the dynamometer while having their arm aligned with the trunk and pointing downward. The maximal isometric contraction was set to last 2 s and participants completed two trials with a minimum 30 s break in between. The assessment was done for both hands, handgrip strength obtained from the preferred hand was rounded to the nearest 0.1 kg and the maximum values of the tests were involved in the further analysis.

Cortisol measurements. The basic level of free cortisol was estimated by the Cortisol (RE52611) Saliva ELISA kit of IBL (Hamburg, Germany). Basic level of cortisol was achieved by keeping off physical stress (physical activity, significant changes of environmental parameters as temperature, humidity, etc.) and emotional stress (fear, nervousness, panic, etc.) 1 h before and during the saliva collection [23]. By following the kit protocol and recommendations, subjects were

asked to avoid eating, drinking, chewing gum or brushing their teeth for 30 min before sampling. Saliva samples were stored at $-20°C$ (no longer than 2 weeks before the assays), warmed up to room temperature and centrifuged to separate the mucins. All standards, samples and controls were run in duplicates, the absorbance of each well was determined with an Epoch 267,860 microtiter plate reader at 450 nm. There is a physiological fluctuation of cortisol level during a day, therefore the exact times of awakening and saliva sample collection were registered and the time after awakening was calculated. The level of free cortisol was expressed in the percentage of the reference cortisol level for the time after awakening, which references were defined by the IBL cortisol kit. Subjects were divided into subgroups with low, average and high cortisol levels by considering the normal range (5th and 95th percentiles) of cortisol level by the time of awakening suggested by the kit.

Questionnaires. Perceived stress levels were measured by the Perceived Stress Scale with 14 items (PSS-14) [24, 25]. Frequency of psychosomatic symptoms was assessed by questionnaire [26]. The level of habitual physical activity (frequency, duration, sports, qualification, sport-related experiences) were measured by using our self-reported questionnaires [27]. For this investigation the total weekly hours of sports participation was used for the selection of examined students. Cut off points of PA levels based on the international recommendation [6]: minimioum 30 min PA a day (non-sporting group with less than 3 h PA per week) and the minimum 60 min PA a day (sporting group with more than 7 h per week).

Statistics. Data were analysed with the use of Statistica 12 for Windows software (StatSoft Inc., Tulsa, OK 74104, USA) and SPSS for Windows v. 20 (SPSS Inc., Chicago, Ill., USA). Variables were checked for normality by Kolmogorov-Smirnov test. Values of skinfolds were log transformed in order to achieve normality. Correlation patterns (linear Pearson-correlation) of the cortisol level and perceived stress, psychosomatic symptoms, and sport activity hours per week were analysed. The correlation was considered 'low' if the correlation coefficient (r) was less than 0.5, 'moderate' between 0.5 and 0.7, and 'strong' above 0.7. Differences between genders were tested by Student's *t*-test. Differences in the respective subgroup's means were tested by one-way ANOVA (Tukey's post-hoc test) and Chi-square test. The level of effective random error was set at 5% in all significance tests ($P < 0.05$).

RESULTS

There were significant differences between males and females and the subgroups of sporting and non-sporting students (Table 1). Females had lower mean values of BMI than males ($P < 0.001$), independent of their physical activity level. Fat percentage values were higher in females than in males ($P < 0.001$), and higher in non-sporting than in sporting students ($P < 0.001$). Muscle percentage values of sporting males were higher than of the other subgroups ($P < 0.001$), but muscle percentage did not differ between non-sporting males and non-sporting females, moreover sporting females had more relative muscle mass than the non-sporting males ($P < 0.001$). The mean of the visceral fat area was the highest in non-sporting males ($P < 0.001$). Handgrip strength was significantly higher in males ($P \leq 0.001$) and differed between sporting and non-sporting subgroups ($P < 0.001$).

Table 1. Basic statistics of age, handgrip strength and body structural parameters in four subgroups (Mean ± SD)

	Sporting males	Sporting females	Non-sporting males	Non-sporting females
Age (yrs)	22.49±2.04	22.57±1.55	23.21±1.77	22.85±1.85
BMI (kg m^{-2})	23.99±2.09	21.48±2.31*	23.39±4.36	20.73±2.18*
Fat%	12.01±3.91	17.49±5.44*+	23.22±5.34	25.79±3.73*+
Bone%	16.19±1.15	14.97±1.14*+	16.79±1.15	16.52±0.92+
Muscle%	47.64±1.87	43.58±2.59*+	40.07±2.61	39.37±3.02+
Visceral fat area (cm^2)	42.46±22.93	49.34±21.61	81.24±34.59+	51.08±18.91*
Handgrip strength (kg)	52.40±8.71	33.95±5.16*+	45.85±8.61	28.56±4.94*+

*significant gender differences.
+significant differences between sporting and non-sporting groups.

There were significant differences among sporting and non-sporting females: with respect to mean ($P = 0.011$) and median ($P = 0.002$) values of cortisol, non-sporting females showed higher levels of cortisol than the sporting females (Table 2).

Basic level of salivary cortisol revealed a significant relation with the level of physical activity: sporting students had lower levels of cortisol both in males and females ($P < 0.01$). A higher percentage of students had low level of cortisol in sporting subgroups in both genders (sm: 29%

Table 2. Mean and median of cortisol in four subgroups

	Sporting males	Sporting females	Non-sporting males	Non-sporting females
Cortisol (μg dL^{-1})	0.212±0.188	0.211±0.166	0.254±0.203	0.362±0.412+
Cortisol median (μg dL^{-1})	0.139±0.030	0.140±0.029	0.157±0.040	0.171±0.061+

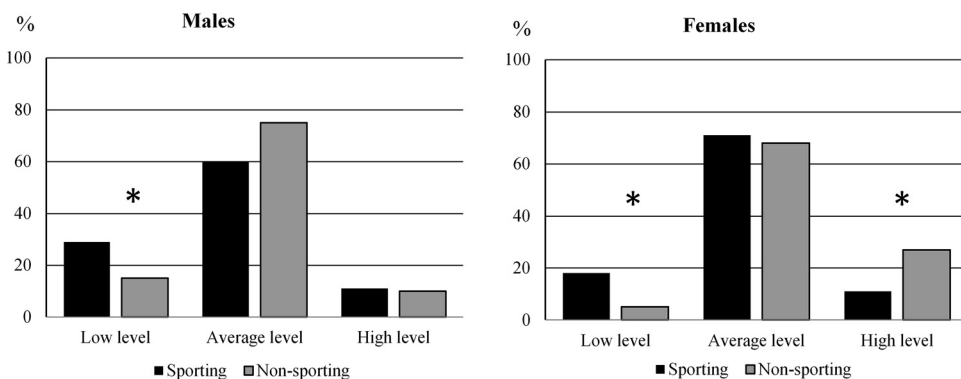+significant differences between sporting and non-sporting groups.

Fig. 1. Relative frequency (%) of university students by salivary cortisol level in male and female subgroups formed by the physical activity.
Abbr: cortisol level – low, average, high cortisol levels by considering the normal range (5th and 95th percentiles) of cortisol level by the time of awakening suggested by the kit; *: significant difference

vs. nsm: 15%; sf: 18% vs. nsf: 5%). A higher percentage of non-sporting female students showed high level of cortisol (27% vs. 11%) (χ^2 tests, $P < 0.05$).

The percentages of students with low basic level of cortisol was significantly higher in students having higher level of physical activity both in males and females, while the percentage of students with high basic level of cortisol was higher in female students having lower level of physical activity (Fig. 1).

The mean perceived stress level in females was significantly higher than in males (total scores − sm: 21.0 ± 5.7 vs. sf: 25.5 ± 7.0; nsm: 23.3 ± 7.2 vs. nsf: 28.0 ± 9.7; ($P < 0.001$)).

The psychosomatic symptoms' frequencies were also significantly higher in females compared to males (total scores − sm: 14.6 ± 6.3 vs. sf: 20.4 ± 7.4; nsm: 14.9 ± 6.1 vs. nsf: 19.6 ± 8.2; ($P < 0.001$)) (Fig. 2).

Sporting males showed significant lower scores in psychosomatic symptoms ($P = 0.002$) and in perceived stress level than non-sporting females ($P < 0.001$). The other differences between sporting and non-sporting groups were not significant.
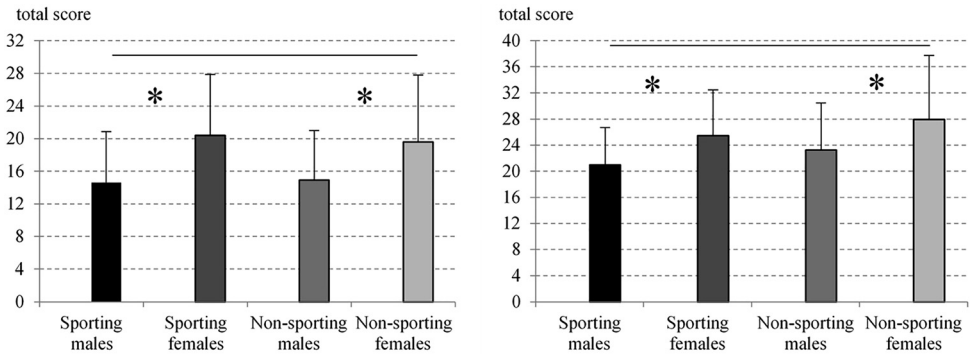

Fig. 2. Psychosomatic symptoms total score (left) and perceived stress level (right, PSS14) mean ± SD in sporting and non-sporting males and females. Abbr: *: significant gender difference, —: significant difference between sporting and non-sporting groups

Table 3. Correlation (Pearson) pattern with sport activity hours per week

Correlation with sport hours per week	r	P
Body mass index (kg m^{-2})	0.297	<0.001
Fat mass (kg)	−0.180	0.013
Relative fat mass (%)	−0.288	0.000
Visceral fat area (cm^2)	−0.081	0.261
Muscle mass (kg)	0.325	<0.001
Relative muscle mass (%)	0.276	<0.001
Handgrip strength (kg)	0.315	<0.001
Cortisol level (expressed in the percentage of the reference median)	−0.227	0.002
Perceived stress level (total score)	−0.194	0.007
The frequency of psychosomatic symptoms (total score)	−0.068	0.346

Table 4. Correlation (Pearson) pattern of the studied variables with cortisol level

	r (total sample)	P	r (males)	P	r (females)	P
Body mass index (kg m^{-2})	−0.09	0.169	−0.02	0.844	−0.10	0.320
Fat mass (kg)	0.12	0.111	0.13	0.204	0.06	0.555
Relative fat mass (%)	0.25*	<0.001	0.22*	0.029	0.25*	0.011
Visceral fat area (cm^2)	0.12	0.084	0.19	0.06	0.08	0.424
Muscle mass (kg)	−0.09	0.187	0.05	0.593	−0.08	0.394
Relative muscle mass (%)	−0.26*	<0.001	−0.17	0.084	−0.33*	0.001
Handgrip strength (kg)	−0.18*	0.005	−0.07	0.495	−0.32*	0.001
Sport hours per week	−0.22*	0.002	−0.24*	0.020	−0.21*	0.044
Perceived stress level (total score)	0.046	0.525	0.17	0.097	−0.07	0.471
The frequency of psychosomatic symptoms (total score)	0.032	0.655	0.02	0.820	−0.13	0.190

Sport activity hours per week showed low but significant inverse relationships with cortisol level, perceived stress level, absolute and relative fat mass; and a positive relation with BMI, absolute and relative muscle mass, and handgrip strength (Table 3).

The median value of cortisol showed significant but low correlation with relative fat (in both genders) and muscle mass, handgrip strength (in females), and sport hours per week (in males) (Table 4).

DISCUSSION

According to the American College Health Association's "Survey 2006" of university students [28], the most important health problem that is detrimental to students' academic performance was academic stress. 32% of the nearly 100.000 students from this investigation reported that academic stress resulted in an incomplete, dropped course or a lower grade. Most common reported stressors in the academic environment are related to oral presentations, exams, academic overload, lack of time to meet commitments [9, 29, 30]. Academic stress correlated with age, gender and depended on the type of university [8, 12]. In an internet-based study [31] and in another investigation with medical students [32] researchers found that higher physical activity time associated with reduced levels of perceived stress. However, in our sample this association was only true for males. There may be several reasons for these differential findings: females tend to have far more psychosomatic symptoms, perhaps more easily reported about them, and generally even females who exercise regularly spend less time on sports than males.

To cope stress generated from academic challenges (first of all mid-year and end-of-year exams), increased physical activity can be one of the most successful strategies of students [29, 33]. Increased level of physical activity can relate with the psychosomatic status through its influence on the neuroendocrine system by buffering the negative effects of stress on health-related outcomes [13, 30]. Based on some studies the students with higher level of physical activity have better sleep quality and well-being [33, 34]. The appropriate amount of physical

activity that can positively affect the neuroendocrine status and the possible moderators of stress-health-physical activity relations have not been fully identified yet. However, it has been evidenced that the levels of several hormones (among others: corticotropin-releasing hormone, cortisol) is affected by physical exercise [35]. Our aim was to study the endocrine status and perceived stress level of students with different level of physical activity. The analysis resulted that although non-sporting students experienced the same level of stress and psychosomatic symptoms as their sporting age-peers, they had higher basic level of salivary cortisol in both genders. This observation adds further details to the well-known fact [36, 37] that physical activity is associated with health benefits [38]. The role of appropriate level of physical activity in preventing the unfavourable effects of stress has already been evidenced in young, healthy adults.

Although we completed our own study before the COVID 19 pandemic, it was reported from questionnaire studies [39–41] that physical activity's mitigating effect is also present in mentally difficult situations (on-line education and exams, quarantine, isolation etc.). As quarantine and isolation are obviously not conducive to sports or exercise, the need of habitual physical activity for university students should be brought to the attention of all forums.

LIMITATIONS AND STRENGTHS OF THIS STUDY

The observations of this study are limited due to its cross-sectional nature, relative small sample size and self-reported (psychosomatic symptoms, perceived stress level, physical activity) questionnaires, which may be prone to over- or underestimation [42]. Measurement of cortisol levels by saliva is a non-invasive procedure versus invasive blood sampling, but it is a sufficiently accurate objective biomarker in population studies to estimate stress levels [30].

One of the strengths of the present study is that it is the first complex investigation to combine objective and subjective measurements of stress level, habitual physical activity, and anthropometric characteristics of university students in both genders which can provide opportunity to make more effective interventions in order to prevent or treat the high level of stress during college years (e.g. mandatory physical education courses with credits throughout university education, providing alternative sports facilities, sports programmes in campus etc.).

CONCLUSION

- Sporting students both males and females showed larger muscle and smaller fat components, as well as lower level of stress than their non-sporting age-peers.
- Sport activity hours significantly correlated with cortisol and perceived stress level, but there was no correlation with the psychosomatic symptoms.
- Non-sporting females appear to be more vulnerable to the effects of stress as they had the most psychosomatic symptoms and had a higher proportion of individuals with high cortisol levels.

Competing interests: The authors declare that they have no competing interests.

ACKNOWLEDGEMENT

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