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Original Investigation

Changes in body composition and handgrip strength of sports science students in the context of summer break

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Purpose: The phenomenon of reduced physical activity during the summer holidays and the resulting adverse changes in body composition is addressed in the public health literature. This phenomenon in relation to university students has not yet been thoroughly investigated. The aim of this study was to investigate the effect of summer break on body composition and handgrip strength in sports science students.
Methods: Forty-seven male students of the Faculty of Sports Science participated in the first examination conducted in mid-June. Thirty-eight students aged 21.2± .6 years participated in the second examination in early October. Body composition was determined with bioelectrical impedance analysis (Tanita BC 418 MA). Handgrip strength was assessed with a bulb dynamometer. Students were also questioned about physical activity undertaken during the academic year and during summer holidays.
Results: None of the body composition parameters changed significantly in examined students after the summer break (P> .05). Handgrip strength increased significantly after summer holidays (P= .01, d= .423). Body weight, muscle mass, and basal metabolic rate were strongly correlated with handgrip strength after the summer break (R>. 50, P< .05). Number of days devoted to intensive and moderate physical activity decreased substantially during the summertime compared with academic year (P< .00, d= .620 and P< .00, d= .771, respectively).
Conclusions: Despite a reduction in physical activity levels during the summer break, body composition parameters did not change significantly in sports science students. Further research should consider more detailed characteristics of students' physical activity during the summer break.

Keywords: body weight; physical activity; university students; summer holiday

Introduction

Body composition measurements are objective methods of assessing an individual's nutritional status; therefore, they are of interest to sports and physical activity (PA) scientists, nutritionists, and health professionals.[1] A body composition assessment provides insight into both the nutritional status and functional capacity of the human body. It also helps monitor therapeutic interventions and design nutritional strategies.[2] Regardless of body fat, which is an indicator of long-term energy storage, skeletal muscles are also of great importance, and body composition should be measured to understand the metabolic balance between muscle and fat compartments. The body mass index (BMI) is not an accurate measurement of fat-free and fat mass, body cell mass, or fluid mass, and it does not provide information about changes in body weight. Therefore, other methods of assessing body composition, including lean and fat mass, weight gain, weight loss, and age-induced changes, should be used.[3] Bioelectrical impedance analysis (BIA) is one of such methods that measures the ability of hydrated tissues to conduct electricity. Total body impedance is determined to estimate the hydration of fat-free mass (FFM), which is defined as the ratio of total body water (TBW) to FFM and is stable. Body composition measurements can be used to quantify FFM loss, i.e. the loss of body protein.[2]

Body composition is affected not only by nutrition, but also by other factors. Research has shown that body composition may be related to PA levels.[4] The benefits of PA for health and well-being at every stage of human life have been widely documented.[5] Therefore, there is no doubt among researchers that an active lifestyle can decrease the risk of many disabling conditions and chronic diseases, promote well-being and healthy aging.[6] To maintain good health and well-being, the World Health Organization (WHO) recommends at least 150 to 300 minutes of moderate aerobic activity per week (or equivalent vigorous activity) for all adults, and an average of 60 minutes of moderate aerobic PA per day for children and adolescents.[7] These guidelines indicate that regular PA provides significant health benefits.

However, the above does not imply that the awareness of PA is high in the general population. The WHO regularly monitors trends in PA. A recent study found that nearly one-third (31%) of the world's adult population, i.e. 1.8 billion adults, are physically inactive.[7] A study commissioned by the European Commission revealed that 45% of the EU residents never exercise or play sports. In addition, the percentage of

respondents with a sedentary lifestyle has increased by 6% since 2009, from 39 to 45%.[8] Therefore, the promotion of PA in all age groups poses a serious challenge. Physical education (PE) plays an important role in this context because it targets most people from childhood to early adulthood.[9] Sedentary adults are unlikely to engage in sports or recreation at later stages of life, which is why regular PA habits should be instilled at early stages of compulsory education. This is more important because for young people who do not enter higher education, regular participation in PA usually ends upon graduation from high school. On the other hand, college students have one last chance to participate in mandatory, organized PE classes, and teachers have the last chance to influence their attitudes toward PA.[10] First-year university students encounter several challenges due to changes in environment and lifestyle, and their body weight tends to increase during that period.[11] This observation is supported by Gropper et al.[12] who found that around 70% of the surveyed students gained an average of around 3.0 kg over four years of study. Many students gain weight during their college years, which is why healthy eating habits during this period are important for lifelong weight management. Universities should promote PA and create favorable conditions for consolidating regular exercise habits.

Body weight also varies across seasons. Physical activity is higher in spring and summer (April-August) and peaks in July-August, while energy expenditure decreases in winter.[13] However, these conclusions are based on studies that focus on the effects of environmental factors (mostly weather) on PA, without considering PA habits. In contrast, Sasayama, Hikihara and Adachi [14] analyzed the PA of school students and arrived at different conclusions. They found that PA decreases and habitual lifestyles are disrupted during the summer holidays. In addition, physical fitness levels decrease or remain stable between the pre- and post-holiday periods. Considering the importance of maintaining good health and physical condition for as long as possible, maintaining consistent patterns of physical activity regardless of the season, is a very important task. As recent studies have shown, visible improvement in cognitive function after years of neglect in PA requires from six to twelve months of regular exercise.[15]

University students operate in a similar system to high school students: they study for two semesters (winter and summer) and then have an extended summer break (2-3 months). However, there is a general scarcity of studies evaluating seasonal changes in university students' lifestyle (including PA) and the associated changes in weight and body composition. Students pursuing a degree in sports science are a special group. These individuals are expected to have high levels of physical fitness and movement skills at the outset because the study curriculum has been designed to train sports and PA experts. During the academic year, these students regularly participate in mandatory sports classes spanning many hours each week. However, the extent to which PA is an established habit can be determined by examining whether sports science students voluntarily engage in sports and active recreation in their free time. These individuals are not required to exercise in their free time during the academic year because they participate in numerous sports classes, and PA remains a free choice during the summer vacation (which lasts three months in Poland). By design, these individuals are superior to other academic groups in terms of PA and fitness, and having earned their degree, these professionals are expected to promote an active lifestyle. A research study investigating whether sports science students regularly undertake PA outside the university curriculum would undoubtedly produce interesting results. As mentioned earlier, PA or lack thereof affects body composition. Therefore, the aim of this study was to determine potential changes in the body composition of male sports science students during the summer holidays. Moreover, the aim of this study was to determine the effect of summer break on handgrip strength of examined students.

Methods

Study design and participants

This is a one-group observational study. The criterion for participation in the current study was the status of a sports science student in the 2nd year of full-time study. Another criterion for participation in the study was regular physical activity undertaken as a part of the study curriculum, and physical activity undertaken independently. Students, who were unable to undertake regular physical activity during the past three months due to illness or injury, were not enrolled in the study. The proposal to participate in the study was addressed to fifty-two second-year male students of the Faculty of Sports Science. The subjects were invited verbally during swimming classes at the end of May. The students were informed about the purpose and of the study and the research process. Inclusion and exclusion criteria were also presented to the students. Three students did not meet the initial criteria (presence of illness or injury) and were not included in the study. Those who agreed to participate signed informed consent forms. Forty-seven students were examined in the first stage of the study, i.e. in mid-June. Thirty-eight were examined in early October, shortly after the end of the summer break. Finally, the data of thirty-eight male students aged 21.2 ± .6 years with a body height of 1.83 ± .08 m and a body weight of 80.06±10.11 kg were considered in this study. Before the summer break, the participants were asked to follow their normal eating habits. The students were not offered any training program or instructed to undertake PA during the summer break. The study was conducted in accordance with the Declaration of Helsinki, and the research protocol was approved by the local Institutional Review Board (KB 24/23)

Measurements

Physical examinations were conducted in an indoor swimming pool between 9:00 AM and 11:00 AM on three consecutive days. Air temperature in the swimming pool was 27 °C. The students wore swimsuits. Body height was assessed with a Seca 216 stadiometer (Seca GmbH & Co. KG, Hamburg, Germany), and body composition was measured with a Tanita BC 418 MA analyzer (Tanita Corp., Tokyo, Japan). Hand grip strength was measured in the dominant hand with a Baseline 12-0291 Bulb Dynamometer (Fabrication Enterprises Inc., White Plains, NY, USA). The participant sat upright in a chair with his feet and trunk supported, and shoulder adducted. Dominant arm elbow was flexed at 90 degrees, forearm in neutral position, and wrist with 0 to 30 degrees extension. The other arm was placed freely along the torso.[16] At the signal of the investigator, the participant squeezed the bulb as hard as possible for three seconds. Three trials were performed with 30-second pauses in between. The best result was recorded.[17]

Interview

Interviews assessing the participants' PA levels were conducted based on the Global Physical Activity Questionnaire (GPAQ).[18] Previous studies indicate that long-term test-retest reliability of the GPAQ range from 0.53 to 0.83, which is considered an acceptable score.[19] In June, the students were verbally interviewed to determine the time dedicated to moderate PA and vigorous PA each week. The interview was conducted by

an experienced academic lecturer with a PhD. Students were asked to indicate the duration of PA during the study program as well as sports activities performed outside the university. The question was formulated as follows: "how much time do you spend on sports or moderate PA during a typical academic week?". The participants stated the frequency (days per week) and the duration (minutes per session) of all physical activities. The same interview was conducted after the summer break, in October. During the second interview, the students were asked to indicate the amount of PA undertaken during the summer break.

Statistical analysis

The sample size was calculated a priori with a web-based ClinCalc calculator (ClinCalc LCC, Indianapolis, IN, USA). The calculations were based on the study by Pavlovic et al.,[20] where 16 male third-year PE students were assessed for body composition and hand grip strength. Statistical significance was set at $P = .05$, and the power of the test was set at 80%. The recommended sample size was 29 participants.

Statistical calculations were performed in Statistica 13.0 (TIBCO Software Inc., Palo Alto, CA, USA). The Shapiro-Wilk revealed that the data were normally distributed. Differences in body composition parameters and grip strength before and after the summer break were calculated with the Student's t-test for dependent samples. The effect size was calculated as Cohen's *d* in the paired t-test. The relationship between anthropometric variables and hand grip strength was determined based on the values of Pearson's product-moment correlation coefficient. The strength of the correlation was assessed as follows: $R < .1$ – negligible; $.1 < R \leq .3$ – weak; $.3 < R \leq .5$ – moderate; $.5 < R \leq .7$ – strong; $.7 < R \leq .9$ – very strong; $R > .9$, near-perfect.[21] Statistical significance was set at $P < .05$

Results

The values of anthropometric parameters, hand grip strength, and PA levels assessed in the studied group in June and October are presented in Table 1. No statistically significant changes in body composition variables occurred during the summer break. Hand grip strength increased significantly after the summer relative to the baseline. The participants' PA levels decreased significantly during the summer relative to the academic year.

The correlations between hand grip strength and anthropometric variables are presented in Table 2. Body weight, muscle mass, bone mass, and the basal metabolic rate were positively correlated with hand grip strength on both examination dates.

No significant correlations between PA levels and body composition variables were observed during the June examination. However, the amount of time dedicated to intense PA during the summer was inversely and significantly correlated with body weight ($R = -.41$), muscle mass ($R = -.33$), and the basal metabolic rate ($R = -.35$).

Discussion

No significant changes in the students' body composition were noted after the summer break. To the best of our knowledge, this is the first study to analyze the impact of the summer break on the body composition of European students pursuing a degree in sports science. Yoo et al.[22] examined the body composition of undergraduate U.S. college students (male and female) before and after winter holidays. A minor increase in body weight was observed, but body fat percentage did not change. In contrast, body fat percentage and fat mass increased significantly after summer break in U.S. female college volleyball players.[23] A significant increase in body fat percentage and fat mass was also reported in Korean sports science students after the summer holiday.[24] The results of the present study indicate that the participants did not substantially modify their lifestyle habits during the summer, which is why no distinct changes in their body composition were observed after the break. According to Poludniak et al.,[25] sports science students are highly motivated to improve their functional fitness, and most of them undertake some form of PA outside college. Cicchella et al.[26] found that sports science students are characterized by high health awareness, regardless of sex or nationality. These findings support the conclusion that the examined students were able to maintain a healthy body composition by adhering to healthy lifestyle habits during the summer break.

The anthropometric parameters of the analyzed students were similar to those reported in sports science students in Bosnia[27] and Poland.[28] However, some body composition parameters differed from those noted in sports science students in Spain (12.48% body fat in the students analyzed in this study vs. 14.76% in Spanish students, $P = .03$).[29] Additionally, our students were taller (1.83 vs. 1.73m), heavier (80.18 kg vs. 74.81kg) and had lower body fat content (12.48 vs. 17.81%; $P < .000$ for all variables) compared to the police cadets.[30] Despite these differences, the body composition parameters of the students analyzed in the present study were within the European norms for young adult males.[31] In this study, hand grip strength was significantly correlated with muscle mass, body weight, and the BMI. Young people pursuing a degree in health-related fields of study (such as sports science, PE, and physiotherapy) are characterized by high levels of physical fitness, which explains the presence of a relationship between muscle mass and hand grip strength. Xu et al.[32] found moderate, but significant correlations between hand grip strength vs. body height ($R = .24$) and body weight ($R = .34$) in male students of economics and technical universities. In the present study, the correlation between hand grip strength and body height was stronger ($R = .28$ in June, and $R = .30$ in October), but not significant. The results reported by Xu et al.[32] could be attributed to a larger study sample (957 male students). In turn, Ben Mansour et al.[33] observed an association between hand grip strength and body weight in university students with moderate PA levels (five hours per week). These findings suggest that body weight is a strong predictor of hand grip strength in college and university students, regardless of their PA levels.

In the current study, the PA levels of sports science students decreased significantly during the summer break. In contrast, other researchers reported an increase in the PA of adults during the summer season.[34] It should be noted that sports science students demonstrate higher PA levels than young people enrolled in other study programs.[35] These differences could be attributed to the curricula of sports science programs, the students' interests and participation in PA outside university. Although the participants' PA levels decreased during the summer relative to the academic year, the analyzed males were still more physically active than their peers in the general population. Despite the observed decrease, the students' hand grip strength improved after the summer holidays. The increase in handgrip strength in the examined students is difficult to explain in view of the data we have on reduced levels of physical activity during the summer vacation. Further research on this topic should consider detailed and standardized monitoring of physical activity undertaken by students during summer break.[36]

In this study, hand grip strength was assessed with a bulb dynamometer. This device is a highly reliable tool for measuring grip strength, and it can be used interchangeably with spring

Table 1. Anthropometric parameters, handgrip strength, and physical activity levels of male sports science students (n=38) before and after the summer break.

Variables	June	October	*t*-test value	*P*-value	Cohen's *d* effect size	Confidence Interval -95%	Confidence Interval +95%
Body height [m]	1.83±.08	1.83±.07	.213	.812	.000	-.06	.07
Body weight [kg]	80.06±10.11	80.18±10.29	-.379	.706	.059	-.75	.51
Body Mass Index [kg/m^2]	23.61±2.41	23.77±2.36	-1.404	.168	.212	-.39	.07
Body fat [%]	12.48±4.07	12.87±3.78	-1.222	.229	.193	-1.03	.25
Body water [%]	62.16±3.62	61.82±3.32	1.231	.226	.197	-.22	.90
Muscle mass [kg]	66.42±7.69	66.29±8.16	.389	.699	.057	-.54	.80
Bone mass [kg]	3.46±0.37	3.46±0.39	-.138	.890	.000	-.04	.04
Basal metabolic rate [kcal]	2072.60±245.60	2068.10±258.64	.448	.656	.071	-15.86	24.86
Visceral fat [level]	1.71±1.13	1.73±1.11	-.305	.762	.036	-.20	.15
Hand grip strength [pounds per square inch]	24.31±4.62	25.52±4.07	-2.646	.011	.423	-2.14	-.28
Intense effort (days per week)	2.81±1.57	1.63±1.69	3.840	<.000	.620	.55	1.80
Intense effort (minutes per session)	71.84±25.21	44.07±41.42	4.599	<.000	.745	39.99	-15.53
Moderate effort (days per week)	3.34±1.27	1.94±1.46	4.714	<.000	.771	.79	1.99
Moderate effort (minutes per session)	65.52±25.83	50.65±36.96	2.186	.035	.354	1.09	28.65

Table 2. Correlations *(R)* between handgrip strength and anthropometric variables in male sports science students (n=38).

Variables	June	October
Body height	.281	.303
Body weight	.443*	.548*
Body Mass Index	.294	.411*
Body fat	-.012	.141
Body water	-.083	-.201
Muscle mass	.483*	.529*
Bone mass	.483*	.532*
Basal metabolic rate	.476*	.518*
Visceral fat	.185	.296

Legend 2. * *P*<.05

or hydraulic dynamometers.[37] Most authors cited in this paper used non-bulb dynamometers (e.g. Jamar, Takei) that differed in weight, design, and force detection. In the present study, hand grip strength was measured in pounds per square inch (PSI), whereas in other studies, the results were expressed in kilograms (kg) or newtons (N). Therefore, the present findings could not be directly compared with measurements performed by other authors, which may be considered as a limitation of this study. However, this is the first study to objectively assess the impact of the summer break on the body composition of sports science students in Europe, which is a major strength of this work.

Practical implications

Body composition assessment is a simple, non-invasive and non-costly way to obtain information about an important aspect of a person's health. Systematic examination of body composition makes it possible to notice the occurrence of adverse changes (such as the level of visceral fat and percentage of fat) and gives the opportunity to implement appropriate intervention. It seems that monitoring the body composition of sports science students is justified due to their keen interest in their own health status. For this group of university students, the effect of a break from regular exercise routine (caused, for example, by religious holidays or inter-semester break) on their body composition may be of interest. In addition, such studies provide knowledge about the health status of a particular population of academic youth who will professionally promote healthy lifestyles in the future.

Conclusions

Despite a significant decrease in the PA levels of sports science students during the summer break, no changes in their body composition were observed at the end of the break. The participants maintained a healthy body composition and adequate muscle strength during the holidays, which could be largely attributed to their adherence to a healthy lifestyle. Future research should include a more detailed analysis of students' PA during the holidays.

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Informed Consent Statement

All participants signed informed consent.

Ethical Committee approval

Bioethics Committee of the District Medical Chamber in Gdansk, Poland (KB 24/25).

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Conflicts of interest

Authors declare no conflict of interest.

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Author-s contribution

Conceptualization, G.B.; methodology, G.B; software, G.B. and A.O.; validation, G.B. and A.O.; formal analysis, G.B.; investigation, G.B.; resources, G.B. and A.O.; data curation, G.B. and A.O.; writing—original draft preparation, G.B and A.O.; writing—review and editing, G.B. and A.O.; visualization, G.B. and A.O. P; supervision, G.B.; project administration, G.B. and A.O. Both authors reviewed the manuscript critically for important intellectual content. Both authors approved the final version of the manuscript.Both authors have read and agreed to

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