



Agata HORBACZ\*, Mária MAJHEROVÁ\*\*, Richard MELICHAR\*\*\*, Ján JUNGER\*\*\*\*

## SELF-REPORTED PHYSICAL ACTIVITY AND AEROBIC ENDURANCE AMONG FEMALE STUDENTS OF PAVOL JOZEF ŠAFÁRIK UNIVERSITY IN KOŠICE, SLOVAKIA

**How to cite [jak cytować]:** Horbacz, A, Majherová, M., Melichar, R., Junger, J. (2024). Self-Reported Physical Activity and Aerobic Endurance Among Female Students of Pavol Jozef Šafárik University in Košice, Slovakia. *Sport i Turystyka. Środkowoeuropejskie Czasopismo Naukowe*, 7(4), 149–162.

### Deklarowana aktywność fizyczna i wytrzymałość tlenowa studentek Uniwersytetu Pavla Jozefa Šafárika w Koszycach na Słowacji

#### Streszczenie

Jednym z najłatwiejszych sposobów na poprawę zdrowia fizycznego i psychicznego, każdego człowieka jest wybór odpowiedniej aktywności fizycznej (AF). Ogólny jej spadek w ostatnich dziesięcioleciach spowodował wzrost liczby chorób cywilizacyjnych. Studentki szkół wyższych zaniebują AF bardziej niż mężczyźni. Na podstawie naszych badań porównaliśmy AF studentek Uniwersytetu P.J. Šafárika w Koszycach (UPJŠ) z ich rzeczywistą wytrzymałością aerobową. W badaniu wzięło udział 268 studentek z czterech wydziałów UPJŠ. Dane AF zebrano przy użyciu krótkiej wersji Międzynarodowego Kwestionariusza Aktywności Fizycznej (IPAQ). Wydolność tlenową określono na podstawie wyników Beep testu na dystansie 20 m, który następnie przeliczono na szacunkowe wartości VO<sub>2</sub> max. Wyniki były porównywalne z innymi badaniami po przeliczeniu na MET-min/tydzień, ale deklarowana AF studentek studiów licencjackich nie różniła się pomiędzy wydziałami. Istnieje korelacja pomiędzy całkowitą ( $r = 0,24$ ;  $p < 0,05$ ) i wysoką ( $r = 0,34$ ;  $p < 0,05$ ) AF a wytrzymałością tlenową w Beep teście na 20 m. Poziom AF wśród studentek UPJŠ jest zgodny

\* <http://orcid.org/0000-0003-3911-9917>; PhD.; Institute of Physical Education and Sport at Pavol Jozef Šafárik University in Košice, Slovakia; e-mail: agata.horbacz@upjs.sk

\*\* <http://orcid.org/0000-0001-8620-8598>; PhD.; Department of Physics, Mathematics and Technology, Faculty of Humanities and Natural Sciences, University of Prešov in Prešov, Slovakia; e-mail: maria.majherova@unipo.sk

\*\*\* <http://orcid.org/0000-0002-5349-0379>; Mgr.; Institute of Physical Education and Sport at Pavol Jozef Šafárik University in Košice, Slovakia; e-mail: richard.melichar@upjs.sk (corresponding author)

\*\*\*\* <http://orcid.org/0000-0002-9672-653X>; Prof., Paed Dr., PhD.; Institute of Physical Education and Sport at Pavol Jozef Šafárik University in Košice, Slovakia; e-mail: jan.junger@upjs.sk

z poziomem obserwowanym w innych badaniach po zniesieniu zmian obowiązujących w czasie pandemii. Jednak jej mniejsza intensywność może mieć wpływ na wydolność aerobową. Przyszłe cele obejmują zwiększenie zainteresowania studentek AF o umiarkowanej i wysokiej intensywności w celu poprawy wytrzymałości tlenowej i zdrowia.

**Słowa kluczowe:** IPAQ; wytrzymałość aerobowa; studentki studiów wyższych; ekwiwalenty metaboliczne; ocena kondycji fizycznej.

## Abstract

One of the easiest ways to improve everyone's physical and mental health is to choose appropriate physical activity (PA). Its general decline in recent decades has triggered an increase in civilisation-related diseases. Female college students neglect PA more than males. We compared the PA of female undergraduates at the University of P.J. Šafárik in Košice (UPJŠ) to their actual aerobic endurance based on our research. The study comprised 268 female students from four UPJŠ faculties. PA data were gathered using a short version of the International Physical Activity Questionnaire (IPAQ). Aerobic endurance capacity was determined using the results of a 20m beep-test, which was then converted to estimated VO<sub>2</sub> max values. The results were comparable to other studies when converted to MET-min/week, but undergraduate students' self-reported PA did not differ between faculties. A correlation exists between total ( $r = 0.24$ ;  $p < 0.05$ ) and vigorous ( $r = 0.34$ ;  $p < 0.05$ ) PA and 20m beep-test aerobic endurance. The level of PA among female UPJŠ students is in line with that observed in other studies following pandemic prevention measures. However, its lower intensity may affect aerobic performance. Future goals include increasing female students' interest in moderate- and high-intensity PA to improve aerobic endurance and health.

**Keywords:** IPAQ; aerobic endurance; undergraduate female students; metabolic equivalents; fitness evaluation.

## Introduction

Physical activity (PA) is generally considered to be an important component of a healthy lifestyle for undergraduate female students (Ács et al., 2016; Buková et al., 2018). Regular aerobic exercise increases the general discipline of female college students and provides benefits in the form of greater physical fitness and better mental resilience (Zou et al., 2016; Kruk, Bernstein, Aboul-Enein, 2022). The COVID-19 pandemic harmed PA in all aspects of life, particularly among university students who switched to distance education, resulting in decreased physical fitness (Bielec, Omelan, 2022). Research on PA in college students following the COVID-19 pandemic may provide information to help us understand changes in their physical fitness. Students spend most of their time sitting and typically have low VO<sub>2</sub> max values (Sisay, 2021), which is an important indicator of aerobic endurance and is directly related to the amount of PA performed. Low-intensity PA, or even general physical inactivity in leisure time, and the resulting low energy expenditure raise the risk of several chronic diseases in late adulthood, including hypertension, coronary heart disease, diabetes, and de-

pression (Marques, 2018). For this reason, it is critical to maintain physical and mental fitness in adulthood and to participate in PA at all stages of development, not only for prevention but also to improve musculoskeletal, circulatory, and respiratory functions, as well as psychological well-being (Bergier et al., 2012; Kim, Hwang, Park, 2015). Properly performed PA in college can improve the aerobic endurance of college women, implying long-term health benefits as well as help in coping with life's challenges and stresses (Buková, 2018; Liu et al., 2017; Herbert et al., 2020; Li, Xu, 2022; Reuter et al., 2024). Aerobic PA for 500 to 1,000 minutes per week provides the greatest health benefits (Oja, Titze, 2011). In addition to aerobic PA, strength training intervention is important in improving risk factors for metabolic syndrome, suggesting that the beneficial effects of strength training are age-independent and confirming improvements in both metabolic health and physical fitness in female students (Andrade et al, 2021; Wilson et al. 2019). The World Health Organisation (WHO) recommends that adults spend at least 150–300 minutes of moderate-intensity PA per week or 75–150 minutes of vigorous-intensity PA. The WHO also recommends combining moderate-intensity aerobic and vigorous-intensity PA (WHO, 2020). Men show a greater increase in  $VO_2$  max in response to endurance training than women (Zadarko, Junger, Barabasz, 2010; Diaz-Canestro, Montero, 2019). This could also be a result of women generally having lower work capacity and exerting greater effort to achieve the same goal as men (Epstein et al. 2015; Eek, Axmon, 2015). Because of their high emancipation and the blurring of boundaries in the demands on the work performed, they must gradually accept this handicap. One of the most important factors influencing this effort is the amount and intensity of PA performed. This paper aims to compare the self-reported PA of female students from various faculties at the University of Pavol Jozef Šafárik in Košice (UPJŠ) with their actual aerobic endurance.

## Study Questions

In this paper, we sought to answer the following research questions:

1. Are there differences among female faculty students in their declared PA?
2. Are there differences between female students of the faculties in  $VO_2$  max?
3. How much time do female students spend in a sedentary way during the weekend?
4. What is the correlation between the declared PA and  $VO_2$  max of the participants?

## Methods

### Participants

The research sample included 276 women from four faculties at the UPJŠ. These were female undergraduate students who took the courses “Sport” and “Sport Activities” as part of their studies. The participants focused their studies on medicine, natural sciences, and humanities. Table 1 shows the number of participants broken down by faculty and age.

Table 1  
*Number of participants and their age distribution by faculty*

Faculty	n	Age (mean ± sd)
Faculty of Arts (FoA)	51	19.96 ± 1.57
Faculty of Medicine (FoM)	132	20.22 ± 1.37
Faculty of Law (FoL)	42	20.24 ± 1.79
Faculty of Science (FoS)	43	19.70 ± 1.06

n = number of participants; sd = standard deviation

### Measurement protocol

We collected the required data using the long version of the International Physical Activity Questionnaire (IPAQ) short version form (Guidelines for Data Processing, 2005), administered and distributed online through the Google Forms platform. For this paper, we processed questions about the PA those participants had done in the previous week during their leisure time. We were interested in how much time students spent sitting over the weekend. The survey was carried out in two phases: November 2022 and November 2023. The respondents filled out questionnaires online during or shortly after class. We converted participants' PA levels into metabolic equivalents (MET-min/week), as recommended for evaluating the IPAQ questionnaire. We classified the total PA results in MET-min/week as walking, moderate intensity, high intensity, and total. Aerobic endurance data were obtained from the results of a 20-meter multistage fitness test (beep test). These results were then converted to estimated  $\text{VO}_2$  max values using the Léger and Gadoury formula (Léger, Gadoury, 1989). Throughout the test, we monitored heart rate using a Polar H10 sensor. Prior to the study, all the participants provided information about their health status and confirmed their physical activity readiness by answering the questions on the Physical Activity Readiness Questionnaire (PAR-Q). Multiple norms exist for evaluating  $\text{VO}_2$  max (mL/kg/min). These norms have varying ranges of categorization for evaluating aerobic performance. In the 18–25 age group, the lowest category

of  $VO_2$  max values varies from 23.6 mL/kg/min (Zadarko et al., 2010) to 28 mL/kg/min (Kozlowski, Nazar, 1995; Aandstad, 2023). Within the highest classification, individuals exhibit  $VO_2$  max measurements ranging from 42 to over 56 ml/kg/min. Due to the significance of the  $VO_2$  max variable in evaluating aerobic endurance, we opted to employ a more rigorous criterion (Table 2).

Table 2  
Maximal oxygen uptake norms for women (ml/kg/min)

Rating	Age (years)					
	18–25	26–35	36–45	46–55	56–65	65+
excellent	> 56	> 52	> 45	> 40	> 37	> 32
good	47–56	45–52	38–45	34–40	32–37	28–32
above average	42–46	39–44	34–37	31–33	28–31	25–27
average	38–41	35–38	31–33	28–30	25–27	22–24
below average	33–37	31–34	27–30	25–27	22–24	19–21
poor	28–32	26–30	22–26	20–24	18–21	17–18
very poor	< 28	< 26	< 22	< 20	< 18	< 17

Data on  $VO_2$  max norms for women sourced from Topend Sports. “ $VO_2$  max Norms”

### Statistical analysis

We performed statistical analysis using Microsoft Excel and SPSS software. Aside from the mean and standard deviation (SD), other descriptive statistics were used to describe the variables: median (Mdn) and interquartile range (IQR; 25<sup>th</sup>–75<sup>th</sup> percentile). Female students’ PA levels were compared between faculties using the non-parametric ANOVA Kruskal-Wallis’s correlation test, with a significance level of  $p < 0.05$  (\*).

### Results

The FoS demonstrated the highest mean PA level (1776.29 min/week). The FoM had a balanced distribution across intensities, with a high mean in high-intensity activities (1346.67 min/week). These findings show that faculty culture affects female students’ PA preferences across academic disciplines. The detailed assessment of PA levels in MET-min/week is presented in Table 3. The estimated  $VO_2$  max of the participants is shown in Table 4. We compared these values to the norms in Table 2. We discovered that female students of the FoM, FoS, and FoL have below-average  $VO_2$  max. In contrast, female students of the FoA have a low  $VO_2$  max.

Table 3

*IPAQ-based assessment of PA levels in MET-min/week among UPJŠ female students by faculty*

Faculty	Intensity	n	Mean	Mdn	25 <sup>th</sup> percentile	75 <sup>th</sup> percentile	IQR	± sd
FoA	walking	34	1210.81	495.00	396.00	1188.00	792.00	1852.58
	moderate	15	525.33	480.00	120.00	720.00	600.00	336.32
	intensity	12	663.33	520.00	480.00	840.00	360.00	435.00
	total	39	1461.73	1116.00	396.00	1584.00	1188.00	1915.92
FoM	walking	102	825.97	396.00	198.00	990.00	792.00	1065.72
	moderate	41	623.41	360.00	240.00	720.00	480.00	756.89
	intensity	51	1346.67	720.00	480.00	1440.00	960.00	1774.73
	total	117	1525.55	720.00	240.00	1752.00	1512.00	2255.47
FoL	walking	34	893.91	396.00	231.00	1386.00	1155.00	962.22
	moderate	16	423.75	320.00	240.00	480.00	240.00	327.27
	intensity	17	1915.29	960.00	480.00	2160.00	1680.00	2677.08
	total	40	1743.33	834.00	396.00	2394.00	1998.00	2327.20
FoS	walking	38	1111.15	693.00	396.00	1386.00	990.00	1114.05
	moderate	8	518.50	480.00	140.00	840.00	700.00	433.95
	intensity	16	1542.50	1040.00	520.00	2640.00	2120.00	1169.75
	total	40	1776.29	904.50	594.00	3229.50	2635.50	1742.10

n = number of participants; Mdn = median; IQR = interquartile range; ± sd = standard deviation; Total PA was calculated in MET-min/week = sum of walking, moderate and high-intensity PA MET-min/week

Table 4

*Predicted VO<sub>2</sub> max (ml/kg/min) in female undergraduate students of UPJŠ based on the result of the BEEP test according to calculations of Léger & Gadoury (1989)*

Faculty	n	Mean	Mdn	25 <sup>th</sup> percentile	75 <sup>th</sup> percentile	IQR	± sd
FoA	51	32.79	33.24	29.95	36.54	6.59	4.71
FoM	132	34.34	33.24	33.24	36.54	3.30	4.44
FoL	42	34.03	33.24	29.95	36.54	6.59	5.19
FoS	43	33.24	33.24	29.95	36.54	6.59	4.32

n = number of participants; Mdn = median; IQR = interquartile range; ± sd = standard deviation

Table 5

*IPAQ-based assessment of sitting time during the weekend among UPJŠ female students by faculty (minutes)*

Faculty	n	Mean	Mdn	25 <sup>th</sup> percentile	75 <sup>th</sup> percentile	IQR	± sd
FoA	51	684.51	615	510	720	210	330.56
FoM	132	897.27	840	660	1080	420	359.19
FoL	42	649.64	600	480	840	360	247.89
FoS	43	693.26	600	480	840	360	304.76

n = number of participants; Mdn = median; IQR = interquartile range; ± sd = standard deviation

Within the self-reported PA, there was no significant difference between faculties in the most observed and effective forms, i.e. moderate, vigorous, and total PA, as well as in  $VO_2$  max. Statistically significant differences were observed ( $p = 0.001^*$ ) in the average time spent sitting during the weekend among all study cohorts of female undergraduate students (Table 6). Students from the FoM had the longest periods of sedentary behaviour on their free days (Table 5). The data analysis showed a significant positive correlation between self-reported physical activity (PA) and aerobic endurance. This was demonstrated by a higher amount of metabolic equivalent (MET-min/week), which measures exercise intensity, being positively linked to higher maximal oxygen uptake ( $VO_2$  max), indicating greater aerobic capacity. A positive correlation was observed between estimated  $VO_2$  max and total self-reported physical activity ( $r = 0.24$ ;  $p < 0.05$ ), as well as with vigorous physical activity ( $r = 0.34$ ;  $p < 0.05$ ). The pattern was consistent among all faculties, although there were slight variations as outlined in Table 7.

Table 6  
Significance of PA level differences between UPJŠ faculties

Indicator	p-value
walking	0.104
moderate intensity	0.884
high intensity	0.117
total	0.382
sitting time (weekends)	<b>0.001*</b>
$VO_2$ max	0.101

\* =  $p < 0.05$

Table 7  
Correlations between PA intensity and  $VO_2$  max across UPJŠ faculties

Faculty	Total (n = 268)	FoA	FoM	FoL	FoS
walking	0.07	0.22	0.06	-0.01	0.06
moderate intensity	-0.02	0.13	-0.03	-0.29	0.12
high intensity	<b>0.34*</b>	<b>0.36*</b>	<b>0.28*</b>	<b>0.45*</b>	<b>0.46*</b>
total	<b>0.24*</b>	<b>0.29*</b>	<b>0.18*</b>	<b>0.30*</b>	<b>0.33*</b>

\* =  $p < 0.05$ .

## Discussion

We hypothesised that the higher PA declared by students using a MET-min/week value would result in a higher  $VO_2$  max. Our research confirmed this

assumption, with the majority of faculty reporting intense and total PA. Thus, we can state the well-known fact that when this relationship is confirmed, the plausibility of students' reported PA is also indicated. In Aandstad's (2023) study, low, medium, and high correlations were observed between declared and objectively measured endurance and muscle strength. More women than men overestimated their true level of fitness. The mean total leisure-time PA reported by participants in our study ranged from 1461.73 MET-min/week to 1776.29 MET-min/week (Table 3). These results are either comparable or significantly higher than the results obtained from a sample of university students from Visegrad and Ukraine (Bergier et al., 2018), which had an average of 1470.1 MET-min/week. This may be a response to the COVID-19 pandemic, as the Visegrad and Ukrainian studies were conducted before the pandemic, whereas our study was conducted during the last phase of the pandemic, after the relaxation of preventive measures. The level of PA is typically an indicator of aerobic performance. In another investigation, the researchers found that the final  $\text{VO}_2$  max in the aerobic endurance test was  $32.53 \pm 3.36$  ml/kg/min (Chatterjee et al., 2010). The maximal oxygen uptake Chatterjee et al. (2010) measured is still considered below average according to the standards outlined in Table 2. A study conducted across different fields of study (Zadarko, Barabasz, Penar-Zadarko, 2009) provides an even better opportunity to compare our results. The authors presented their findings without regard to gender, with philology students having the lowest estimated  $\text{VO}_2$  max (33.86 ml/kg/min) and physical education students having the highest estimated  $\text{VO}_2$  max (43.49 ml/kg/min). The average  $\text{VO}_2$  max of students across all disciplines studied in their study was 37.51 ml/kg/min. Their findings align with the results obtained in our research, falling within the average or below-average categories. We can also use the Nizioł-Babiarz study's results (2022) to compare our estimated  $\text{VO}_2$  max values to real measured  $\text{VO}_2$  max values. They conducted a beep test with 309 student participants from five Polish universities. They used the K4b2 gas analyser mask (Cosmed, Italy) and found that the average  $\text{VO}_2$  max value of the women in their study was 44.3 ml/kg/minute. This is the only result we found that meets the standards for being above average. Before the COVID-19 pandemic, numerous authors discussed the problem of inactivity, which is linked to a decrease in PA. It is crucial to monitor the impact of being inactive to encourage and sustain a healthy way of life. Information regarding inactivity also functions as a significant incentive for young individuals to reduce their sitting time and increase their participation in PA (Son et al., 2020). Engaging in low-intensity PA does not result in a significant elevation of heart rate, as indicated by a study (Bull et al., 2020). The study examining the sedentary habits of high school and university students (Šimůnek et al., 2017) discovered that even within the specific region where this study was conducted, university students spend just under five hours per day sitting during



weekends. The global measures employed during the lockdown caused an even greater shift in the ratio of PA to sitting. Several authors addressed this issue at the time, and they discovered a further decrease in total PA, with all participants increasing their walking and rest time (Ács et al., 2020; Luciano et al., 2021). Before the pandemic, sitting time was well under 6 hours per day, but during the pandemic, it was already more than 6 and a half. Slightly higher sitting time was obtained during the lockdown period in a study in which Malaysian students spent an average of 9.16 hours per day sitting and Indonesian students 7.85 hours per day (Tan et al., 2021). One year after the pandemic, Roggio et al. (2021) discovered that low levels of PA in university students resulted in the onset of musculoskeletal pain and its progressive worsening. Two years after the end of pandemic measures, students of the FoM UPJŠ are sitting in their free time (during the weekend) for an average of 7.5 h/day. Slightly shorter sitting times were reported in the questionnaire by female students from other faculties, who reported sitting times during weekends ranging from 5 to 5.5 h/day (Table 5). The differences between universities and faculties can be attributed to their structure, particularly the requirements placed on mastering the chosen curriculum. This could also explain the sitting time of the FoM students, who, due to the greater representation of medical courses, require more permanent preparation for their studies. Considering the findings of our research and the practical evidence from teaching, we urge for acceptance of the minimum PA values recommended by the World Health Organisation (WHO, 2020). This adherence will help improve the overall health and enhance the aerobic endurance of the population. The pandemic has altered behaviour and caused a variety of physical and mental health issues among university students (Son et al., 2020). As a result, the authors recommend compensatory PA sessions of any type and intensity, which have numerous health benefits. To improve the lifestyle of female university students, meaningful, holistic programmes must be developed to motivate and encourage them to participate in regular PA. Based on our and others' findings, the regularity and quantity of PA hours in the university setting should be considered. PA interventions should be targeted, with a particular emphasis on improving the physical fitness of female students (Wilson et al., 2019; Buková et al., 2019). However, practice demonstrates the opposite. Most colleges are reducing so-called "secondary" courses, owing to insufficient budgets for curriculum provision. Most of these are PA courses. This credit battle completely ignores the principle already expressed by the father of medicine, Hippocrates, who said that "the organ that is destined to function must perform it, otherwise it ceases to exist". As a result, his successor, the physician, and philosopher Galen of Pergamum included PA among the four basic needs necessary for human survival: food, drink, rest, and exercise (Junger, 2020).

## Conclusion

Regarding the research questions, we can conclude that our findings did not support the predicted significant difference in PA levels among undergraduate students from different fields of study. When considering the metabolic equivalent of the task (MET-min/week), the students' PA levels are consistent with those reported in previous studies, suggesting that discipline may not be a primary factor influencing overall PA engagement. Despite these comparable PA levels, notable differences emerged in aerobic endurance between faculties, with aerobic endurance significantly lower than that observed in prior investigations. This indicates that PA levels alone may not fully explain variations in physical fitness, possibly due to discipline-specific factors such as curriculum demands or lifestyle patterns. Female students' sedentary time on weekends was slightly lower than the pre-pandemic levels reported in other studies. Most female students sit for roughly one-fifth of the day, with medical students sitting for nearly one-third of the day on weekends. This suggests a lingering effect of the pandemic on sedentary behaviour, particularly in academically demanding programs like medicine, where prolonged sitting is more prevalent. Our findings confirmed the relationship between reported total and vigorous PA in the IPAQ and aerobic endurance. This positive correlation supports the plausibility and reliability of the self-reported PA data compared to the objectively measured aerobic capacity. However, there was no evidence to support a relationship between walking or moderate-intensity PA and aerobic endurance, consistent with existing literature that underscores the limited impact of moderate PA on improving aerobic fitness. Our findings validate and highlight the critical need for developing interventions to promote and advocate for PA among college students.

Universities must focus on creating environments conducive to regular PA participation, with particular emphasis on raising awareness of the health benefits of PA and encouraging its integration into students' daily routines.

## Limitations

The limitation of our study is that the data were gathered using the internationally used IPAQ questionnaire in its online version. It is very difficult to understand and complete the questionnaire. We lacked longitudinal data to compare differences between the observed PA factors and aerobic endurance.

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### STATEMENT OF ETHICS

This study was conducted in accordance with the World Medical Association Declaration of Helsinki. The study protocol was reviewed and approved by the Pavol Jozef Šafárik University Ethics Committee in Košice under number EK No. 3/2023. All participants provided written informed consent to participate in this study.

### DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interests with respect to the research, authorship, and/or publication of the article *Self-Reported Physical Activity and Aerobic Endurance Among Female Students of Pavol Jozef Šafárik University in Košice, Slovakia*

### FUNDING

The authors received no financial support for the research, authorship, and/or publication of the article *Self-Reported Physical Activity and Aerobic Endurance Among Female Students of Pavol Jozef Šafárik University in Košice, Slovakia*

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## References

- Aandstad, A. (2021). Relationship between self-reported and objectively measured physical fitness in young men and women. *European Journal of Sport Science*. <https://fhs.brage.unit.no/fhs-xmlui/handle/11250/2837843>.
- Ács, P., Bergier, B., Bergier, J., Niżnikowska, E., Junger, J., & Salonna, F. (2016). Students Leisure Time as a Determinant of Their Physical Activity at Universities of the Eu Visegrad Group Countries. *Health Problems of Civilization*, 10(4), 31–41. <https://doi.org/10.5114/hpc.2016.63569>.
- Ács, P., Prémusz, V., Morvay-Sey, K., Pálvölgyi, Á., Trpkovici, M., Elbert, G., Melczar, C., & Makai, A. (2020). Effects of Covid-19 on Physical Activity Behavior Among University Students: Results of a Hungarian Online Survey. *Health Problems of Civilization*, 14(3), 174–182. <https://doi.org/10.5114/hpc.2020.98472>.
- Andrade, D. C., Flores-Opazo, M., Peñailillo, L., Delgado-Floody, P., Cano-Montoya, J., Vásquez-Gómez, J. A., & Alvarez, C. (2021). Similar Adaptations to 10 Weeks Concurrent Training on Metabolic Markers and Physical Performance in Young, Adult, and Older Adult Women. *Journal of Clinical Medicine*, 10(23), Article 23. <https://doi.org/10.3390/jcm10235582>.
- Bergier, J., Kapka-Skrzypczak, L., Biliński, P., Paprzycki, P., & Wojtyła, A. (2012). Physical activity of Polish adolescents and young adults according to IPAQ: A population based study. *Annals of Agricultural and Environmental Medicine: AAEM*, 19(1), 109–115.

- Bergier, J., Tsos, A., Popovych, D., Bergier, B., Niżnikowska, E., Ács, P., Junger, J., & Salonna, F. (2018). Level of and Factors Determining Physical Activity in Students in Ukraine and the Visegrad Countries. *International Journal of Environmental Research and Public Health*, 15(8), Article 8. <https://doi.org/10.3390/ijerph15081738>.
- Bielec, G., & Omelan, A. (2022). Physical Activity Behaviors and Physical Work Capacity in University Students during the COVID-19 Pandemic. *International Journal of Environmental Research and Public Health*, 19(2), 891. <https://doi.org/10.3390/ijerph19020891>.
- Buková, A. (2018). *Životný štýl a zdravotný stav vysokoškoláčov v reflexii ich športovej aktivity*. Košice: UPJŠ.
- Buková, A., Zusková, K., Szerdiova, L., & Horbacz, A.D. (2019). Selected lifestyle factors of female university students in the reflection of sports activities. *Health Problems of Civilization*, 13(1), 38–47. <https://doi.org/10.5114/hpc.2019.81109>.
- Bull, F.C., Al-Ansari, S.S., Biddle, S., Borodulin, K., Buman, M.P., Cardon, G., Carty, C., Chaput, J.-P., Chastin, S., Chou, R., Dempsey, P.C., DiPietro, L., Ekelund, U., Firth, J., Friedenreich, C.M., Garcia, L., Gichu, M., Jago, R., Katzmarzyk, P. T., Willumsen, J. F. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British Journal of Sports Medicine*, 54(24), 1451–1462. <https://doi.org/10.1136/bjsports-2020-102955>.
- Chatterjee, P., Banerjee, A.K., Das, P., & Debnath, P. (2010). A Regression Equation for the Estimation of Maximum Oxygen Uptake in Nepalese Adult Females. *Asian Journal of Sports Medicine*, 1(1). <https://doi.org/10.5812/asjasm.34873>.
- Diaz-Canestro, C., & Montero, D. (2019). Sex Dimorphism of VO<sub>2</sub>max Trainability: A Systematic Review and Meta-analysis. *Sports Medicine*, 49, 1949–1956. <https://doi.org/10.1007/s40279-019-01180-z>.
- Eek, F., & Axmon, A. (2015). Gender inequality at home is associated with poorer health for women. *Scandinavian Journal of Public Health*, 43, 176–182. <https://doi.org/10.1177/1403494814562598>.
- Epstein, Y., Fleischmann, C., Yanovich, R., & Heled, Y. (2015). Physiological and Medical Aspects That Put Women Soldiers at Increased Risk for Overuse Injuries. *Journal of Strength and Conditioning Research*. <https://doi.org/10.1519/JSC.0000000000001079>.
- Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ) – Short and Long Forms*. (2005). <https://sites.google.com/site/theipaq/scoring-protocol>.
- Herbert, C., Meixner, F., Wiebking, C., & Gilg, V. (2020). Regular Physical Activity, Short-Term Exercise, Mental Health, and Well-Being Among University Stu-

- dents: The Results of an Online and a Laboratory Study. *Frontiers in Psychology*, 11. <https://doi.org/10.3389/fpsyg.2020.00509>.
- Junger, J. (2020). Čo sa musí stať, aby sme sa začali hýbať?! *Universitas Šafariakiana*, 47(2), 31–33.
- Kim, D.K., Hwang, J.H., & Park, W.H. (2015). Effects of 4 weeks preoperative exercise on knee extensor strength after anterior cruciate ligament reconstruction. *Journal of Physical Therapy Science*, 27(9), 2693–2696. <https://doi.org/10.1589/jpts.27.2693>.
- Kozłowski, S., & Nazar, K. (1995). *Wprowadzenie do fizjologii klinicznej*. Warszawa: PZWL.
- Kruk, J., Bernstein, J., & Aboul-Enein, B. H. (2022). Obesity, Physical Activity and Prostate Cancer: An Overview. *Central European Journal of Sport Sciences and Medicine*, 38, 71–91. <https://doi.org/10.18276/cej.2022.2-07>.
- Léger, L., & Gadoury, C. (1989). Validity of the 20m shuttle run test with 1 min stages to predict VO<sub>2</sub>max in adults. *Canadian Journal of Sport Sciences = Journal Canadien Des Sciences Du Sport*, 14(1), 21–26.
- Li, H., & Xu, L. (2022). Analysis of cardiopulmonary resistance under different loads in aerobic exercises. *Revista Brasileira de Medicina Do Esporte*. [https://doi.org/10.1590/1517-8692202228062022\\_0078](https://doi.org/10.1590/1517-8692202228062022_0078).
- Liu, J., Shanguan, R., Keating, X., Leitner, J., & Wu, Y. (2017). A conceptual physical education course and college freshmen's health-related fitness. *Health Education*, 117, 53–68. <https://doi.org/10.1108/HE-01-2016-0002>.
- Luciano, F., Cenacchi, V., Vegro, V., & Pavei, G. (2021). COVID-19 lockdown: Physical activity, sedentary behaviour and sleep in Italian medicine students. *European Journal of Sport Science*, 21(10), 1459–1468. <https://doi.org/10.1080/17461391.2020.1842910>.
- Marques, A., Santos, T., Martins, J., Matos, M.G.D., & Valeiro, M.G. (2018). The association between physical activity and chronic diseases in European adults. *European Journal of Sport Science*, 18(1), 140–149. <https://doi.org/10.1080/17461391.2017.1400109>.
- Nizioł-Babiarz, E. (2022). *Wytrzymałość krążeniowo-oddechowa młodzieży akademickiej w aspekcie budowy somatycznej i aktywności fizycznej czasu wolnego*. PhD dissertation. Uniwersytet Szczeciński w Szczecinie, Wydział Kultury Fizycznej i Zdrowia.
- Oja, P., & Titze, S. (2011). Physical activity recommendations for public health: Development and policy context. *EPMA Journal*, 2(3), 253–259. <https://doi.org/10.1007/s13167-011-0090-1>.
- Reuter, M., Rosenberger, F., Barz, A., Venhorst, A., Blanz, L., Roecker, K., & Meyer, T. (2024). Effects on cardiorespiratory fitness of moderate-intensity training vs. Energy-matched training with increasing intensity. *Frontiers in Sports and Active Living*, 5. <https://doi.org/10.3389/fspor.2023.1298877>.

- Roggio, F., Trovato, B., Ravalli, S., Di Rosa, M., Maugeri, G., Bianco, A., Palma, A., & Musumeci, G. (2021). One Year of COVID-19 Pandemic in Italy: Effect of Sedentary Behavior on Physical Activity Levels and Musculoskeletal Pain among University Students. *International Journal of Environmental Research and Public Health*, 18(16), Article 16. <https://doi.org/10.3390/ijerph18168680>.
- Šimůnek, A., Frömel, K., Salonna, F., Bergier, J., Junger, J., & Ács, P. (2018). Sedavé chování a vybrané aspekty pohybové aktivity SŠ a VŠ studentů. *Tělesná Kultura*, 40(2), 105–111. <https://doi.org/10.5507/tk.2016.011>.
- Sisay, T. (2021). Physical Inactivity as a Pandemic: Daily Activities and Dietary Practices. *Risk Management and Healthcare Policy*, 14, 3287–3293. <https://doi.org/10.2147/RMHP.S317440>.
- Son, C., Hegde, S., Smith, A., Wang, X., & Sasangohar, F. (2020). Effects of COVID-19 on College Students' Mental Health in the United States: Interview Survey Study. *Journal of Medical Internet Research*, 22(9), e21279. <https://doi.org/10.2196/21279>.
- Tan, S.T., Tan, C.X., & Tan, S.S. (2021). Physical Activity, Sedentary Behavior, and Weight Status of University Students during the COVID-19 Lockdown: A Cross-National Comparative Study. *International Journal of Environmental Research and Public Health*, 18(13), Article 13. <https://doi.org/10.3390/ijerph18137125>.
- Wilson, O.W.A., Papalia, Z., Duffey, M.L., & Bopp, M. (2019). Differences in college students' aerobic physical activity and muscle-strengthening activities based on gender, race, and sexual orientation. *Preventive Medicine Reports*, 16. <https://doi.org/10.1016/j.pmedr.2019.100984>.
- Wood, R. (2012). *Norm values for VO2max*. Topend Sports Website. <https://www.topendsports.com/testing/norms/vo2max.htm>.
- World Health Organization (WHO): *Physical activity*. (2020). <https://www.who.int/news-room/fact-sheets/detail/physical-activity>.
- Zadarko, E., Barabasz, Z., & Penar-Zadarko, B. (2009). Assessment of students' physical efficiency in the context of health promotion system. In *Academic Physical Education* (pp. 43-55). Rzeszow: Wydawnictwo UR Rzeszow.
- Zadarko, E., Junger, J., & Barabasz, Z. (2010). *Physical activity and health of the students from Carpathian Euroregion*. Wydawnictwo Uniwersytetu Rzeszowskiego, PWSZ.
- Zou, Z., Liu, Y., Xie, J., & Huang, X. (2016). Aerobic Exercise As a Potential Way to Improve Self-Control after Ego-Depletion in Healthy Female College Students. *Frontiers in Psychology*, 7. <https://doi.org/10.3389/fpsyg.2016.00501>.