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Accelerometer-derived physical activity and health correlates among students in the Visegrad Group countries

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Authors' contribution:

A. Study design/planning
B. Data collection/entry
C. Data analysis/statistics
D. Data interpretation
E. Preparation of manuscript
F. Literature analysis/search
G. Funds collection

Abstract

Background. Currently, there is a limited amount of objective data concerning university students from the Visegrad Group (V4) countries. The aim of the present study was to analyze the level of physical activity assessed using accelerometers, along with an examination of its associations with selected health indicators.

Material and methods. The study involved 197 students from V4 countries, who wore accelerometers for seven consecutive days. The recorded data were processed using established cut-off points for different intensities of physical activity.

Results. The findings indicated that most students met the latest WHO guidelines for physical activity. Within the structure of daily physical activity, moderate-intensity activity predominated (Mdn=41 min/day), while the proportion of vigorous-intensity efforts was small (Mdn=1 min/day). Comparative analysis revealed statistically significant differences between countries (p<0.05), indicating diverse activity patterns among the studied youth. Correlations between physical activity levels and self-rated health and BMI were weak or moderate.

Conclusions. The results suggest that the mere number of minutes spent in moderate to vigorous physical activity does not fully reflect the health-promoting potential of students' physical activity. The study also highlights the need for longitudinal research to determine whether the observed movement behavior profiles persist into later adulthood and how they impact health.

Keywords: Visegrad Group, accelerometry, health correlates, physical activity, students

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Introduction

The predominance of sedentary behaviors (SB) and insufficient physical activity constitute serious public health challenges for contemporary adolescents and young adults. Scientific evidence from systematic reviews

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and meta-analyses confirms that physical inactivity and prolonged sitting are independent risk factors for chronic non-communicable diseases (NCDs) and all-cause mortality [1,2].

Despite growing public awareness of the importance of physical activity, epidemiological data indicate that more than one quarter of adults worldwide (27.5%) and over three quarters of adolescents (81%) do not meet the 2020 World Health Organization (WHO) recommendations for moderate to vigorous physical activity (MVPA) [3-5]. Early adulthood, including the period of university studies, is particularly important for the development of adult attitudes, including the formation and consolidation of health-promoting physical activity behaviors.

It is estimated that the traditional classroom-based educational model enforces prolonged sitting and limits physical activity to low-intensity efforts [6,7]. As a result, university students can be classified as a "high-risk" group for NCDs. The underlying cause of this situation is prolonged physical inactivity, which consequently becomes one of the main risk factors for these diseases at an early age [8,9].

Contemporary guidelines clearly distinguish SB from insufficient physical activity (physical inactivity). The interchangeable use of these terms often leads to misunderstandings that obscure the true picture of health risks and hinder the implementation of effective health policy interventions. These behaviors are distinct from both total lack of physical activity and insufficient physical activity (inactivity). The latest WHO guidelines in this area [4] emphasize physical activity as defined by Caspersen et al. [10], in which the cumulative level should be at least 150-300 minutes per week of MVPA, or 75-150 minutes per week of vigorous physical activity (VPA), or an equivalent combination of efforts of varying intensity. Failure to meet these recommendations is defined as "insufficient physical activity" (inactivity). It is worth noting that the WHO guidelines do not account for activity of less than moderate intensity, nor do they specify a quantitative threshold for SB duration. This means that, despite evidence of a dose – response relationship regarding the benefits of extremely low and low-intensity efforts and the negative effects of prolonged sitting [11-14], researchers remain cautious in formulating unequivocal recommendations.

Recent studies monitoring physical activity in European populations have prioritized harmonized, accelerometer-based estimates of time spent sitting and MVPA, rather than earlier studies that relied solely on retrospective self-assessment of physical activity, which is subject to memory errors and a need for social approval [15]. Despite methodological limitations, mainly related to the adoption of uniform cut-off points, wear-time algorithms, epoch length, and types of accelerometers, objective measurements supplemented with diaries specifying domains and context of activity may most accurately reflect the accurate picture of movement behaviors at both individual and population levels [16-18].

The Visegrad Group countries (V4: the Czech Republic, Hungary, Poland, Slovakia) form a specific region of Central Europe, where dynamic growth in student numbers coincides with the rapid spread of digital technologies and a screen-based lifestyle. In conditions of heavy academic workload and pervasive digital devices and tools, this tends to reduce spontaneous daily physical activity and may exacerbate the transition of young adults towards a more sedentary lifestyle.

Data on movement behaviors among young people from V4 countries are increasingly available, but for university students, they remain fragmentary and are often based on self-assessment. Currently, comparative data are available from questionnaire-based studies (IPAQ-L) conducted in 2015 [19], as well as partial accelerometer data for youth and young adults from Hungary, the Czech Republic, and Poland [20-22]. However, there remains a lack of multinational accelerometer studies that provide reliable, comparable data on physical activity among students from V4 countries using a uniform, harmonized approach to data collection and processing.

The present study addresses this gap by employing the same device (ActiGraph GT3X+), a standardized wearing protocol, and a consistent approach to data collection and processing.

Aim of the work

This study aimed to compare the movement behaviors of students from four Visegrad countries based on objective accelerometer measurements, focusing on variables relevant to shaping policies addressing insufficient physical activity, defined according to the WHO MVPA thresholds [5]. The results concerning physical activity indicators were related to two practical health indicators – self-rated general health and body mass index (BMI) – in order to identify which of the analyzed risk dimensions may be more significant in the studied population and in which areas intervention efforts may be most justified.

Material and methods

Study design

Objective monitoring of physical activity was conducted among 197 students from four universities in the V4 countries: University of Pécs (Hungary), John Paul II University in Biała Podlaska (Poland), Pavol Jozef Šafárik University in Košice (Slovakia), and University of South Bohemia in České Budějovice (the Czech Republic). Research teams from each university were responsible for local recruitment, data collection, and obtaining approval from their respective Bioethics Committees.

The study was conducted in May 2025. Physical activity and SB were objectively measured using triaxial GT3X+ accelerometers (ActiGraph LLC, Pensacola, FL, USA). Device initialization across all countries followed a uniform protocol: a 30 Hz sampling frequency was set, with 60-second epochs. The 60-second epoch length was chosen in accordance with standard calibration studies in adults [23,24], facilitating comparison with large-scale monitoring datasets such as NHANES. Activity monitoring was conducted over seven consecutive days.

Periods of non-wear time were defined as at least 60 consecutive minutes of zero counts, allowing for up to 1-2 minutes of non-zero counts (<100 counts·min^{-1}) within this interval, in line with commonly used algorithms for adults. Days with ≥600 minutes (≥10 h) of valid wear-time were classified as valid, and participants were required to provide at least four valid days, including at least one weekend day, to be retained in the analyses [25].

Participants wore the accelerometers attached with an elastic belt above the left iliac crest and removed them at night.

Activity intensity was classified using validated cut-off points for adults. Time spent in light-intensity physical activity (LPA) was defined as 100-1,951 counts·min^{-1}, moderate-intensity physical activity (MPA) as 1,952-5,724 counts·min^{-1}, and VPA as ≥5,725 counts·min^{-1}. Total MVPA was calculated as the sum of daily minutes spent in MPA and VPA. For each participant, we computed average daily minutes in LPA, MPA, VPA, and total MVPA across all valid days, and these values were used in the subsequent statistical analyses.

The study sample was characterized by country of origin, age, sex, and basic health indicators such as BMI and self-rated general health. The characteristics of the study population, including the variables, are presented in Table 1.

Table 1. Descriptive characteristics of the study sample by country

Variable	Category	Czech Republic			Hungary			Poland			Slovakia			Total	
		n	%N	Mean±SD	n	%N	Mean±SD	n	%N	Mean±SD	n	%N	Mean±SD	N	%
Age		50	25.4	20.10±0.81	43	21.8	21.86±1.37	49	24.9	21.45±2.39	55	27.9	21.24±1.80	197	100
Gender	**Female**	49	98.0	n/a	40	93.0	n/a	36	73.5	n/a	30	54.5	n/a	155	78.7
	Male	1	2.0		3	7.0		13	26.5		25	45.5		42	21.3
	Total	50	100.0		43	100.0		49	100.0		55	100.0		197	100.0
General health[1]	**Excellent**	3	6.0	2.74±0.83	3	7.0	2.37±0.66	1	2.0	2.80±0.71	5	9.1	2.47±0.74	12	6.1
	Very good	15	30.0		22	51.2		15	30.6		22	40.0		74	37.6
	Good	25	50.0		17	39.5		26	53.1		25	45.5		93	47.2
	Fair	6	12.0		1	2.3		—	—		—	—		7	3.5
	Poor	1	2.0		—	—		7	14.3		3	5.5		11	5.6
	Total	50	100.0		43	100.0		49	100.0		55	100.0		197	100.0
BMI categories[2]	**Underweight (<18.5)**	4	8.0	22.74±3.65	2	4.9	22.74±3.14	3	6.1	24.30±4.41	2	3.8	22.26±2.37	11	5.7
	Normal (18.5-24.9)	37	74.0		30	73.2		28	57.1		42	79.2		137	71.0
	Overweight (25-29.9)	7	14.0		8	19.5		13	26.5		9	17.0		37	19.2
	Obese (≥30.0)	2	4.0		1	2.4		5	10.2		—	—		8	4.1
	Total	50	100.0		41	100.0		49	100.0		53	100.0		193	100.0
Meeting the WHO recommendations[3]	**No**	3	6.0	n/a	—	—	n/a	3	6.1	n/a	7	12.7	n/a	13	6.6
	Yes	47	94.0		43	100.0		46	93.9		48	87.3		184	93.4
	Total	50	100.0		43	100.0		49	100.0		55	100.0		197	100.0

Notes: [1] self-rated general health assessed on a five-point scale: excellent, very good, good, fair, poor; [2] BMI categories according to the WHO classification: underweight (<18.5 kg/m^2), normal (18.5-24.9), overweight (25.0-29.9), obese (≥30.0); [3] based on accelerometer-derived moderate-to-vigorous physical activity (MVPA ≥150 min/week). Values represent frequencies (n) and valid percentages within each country sample. Dashes (—) indicate that no participants were classified in that category.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA). Quantitative variables were presented as the mean (M) and median (Mdn), along with measures of dispersion (SD and Q1-Q3). Differences in SB and insufficient physical activity among students from individual countries were assessed using the Kruskal-Wallis test, while associations between physical activity, BMI, and self-rated health in the entire study population, stratified by country, were evaluated using Spearman's rho test. In comparative analyses, differences were considered statistically significant at $p<0.05$.

Results

Compliance with the WHO physical activity guidelines

The study results demonstrated that the physical activity level of the examined cohort was high and met the latest WHO guidelines [5]. The cumulative time spent in MVPA ranged from 31 to 62 minutes per day between the 25th and 75th percentiles (Mdn=45), indicating that student physical activity was high and even exceeded the upper limit of the recommendation, i.e., 300 minutes per week. It is noteworthy that the time devoted to LPA not included in the WHO recommendations was also high (Mdn=221 min/day). In contrast, VPA was performed infrequently; students only occasionally engaged in intensive efforts, with total daily time not exceeding 4 minutes (Mdn=1 min) (Table 2).

Table 2. Accelerometer-derived daily physical activity of students V4 countries

Variable	LPA	MPA	VPA	Total MVPA
Mean	224	45	4	49
Median	221	41	1	45
SD	63	21	6	24
Min.	58	1	0	1
Max.	402	125	41	151
Q1-Q3	181-266	29-58	0-4	31-62

Notes: Values are expressed in minutes per day (min/day).

Sex differences in physical activity

Statistical analyses that accounted for students' biological sex did not reveal significant differences in either MVPA or LPA levels. However, in the case of vigorous-intensity activities, men achieved significantly higher values than women ($p=0.012$ for VPA and $p=0.021$ for Total Vigorous) (Table 3).

Table 3. Daily physical activity of female and male students

Variable	LPA	MPA	VPA	Total MVPA
Females				
Mean	227	45	3	48
Median	223	42	1	45
SD	60	19	6	22
Minimum	86	7	0	7
Maximum	402	125	41	151
Q1-Q3	183-266	31-58	0-3	31-61
Males				
Mean	210	47	5	52
Median	197	40	4	45
SD	75	27	6	29
Minimum	58	1	0	1
Maximum	391	109	28	119
Q1-Q3	160-262	26-60	0-7	31-65
Mann-Whitney U	2759	3215	2434	3116
Z	-1.51	-0.12	-2.52	-0.43
p	0.130	0.903	0.012*	0.670
Effect size (rrb)	0.15	0.01	-0.25	-0.04

Notes: Values are expressed in minutes per day (min/day). * $p<0.05$ indicates statistically significant sex differences. Effect size (*r*rb) = rank-biserial correlation (≈0.1 small, 0.3 medium, ≥0.5 large).

Cross-country differences in physical activity

A comparative analysis of the physical activity results among students from individual V4 countries revealed significant differences in the structure of students' daily physical activity ($p<0.05$). Hungarian students demonstrated the highest levels of MVPA, while the lowest values were observed in Poland. Differences were also noted in LPA, with the longest duration recorded in the Czech Republic and the shortest, similar to MVPA, in Poland. The differences in physical activity levels among students from the respective countries were statistically significant (Kruskal-Wallis, $p<0.05$), except for activities performed at vigorous and very vigorous intensities. The effect sizes calculated for the observed differences ranged from minor to moderate ($\eta^2H=0.04-0.12$). The results indicate that movement behavior patterns among university students in the V4 countries are not homogeneous (Table 4).

Table 4. Kruskal-Wallis test for physical activity differences among V4 students

Variable	H	*p*	η^2H
LPA	22.84	<0.001*	0.117
MPA	11.13	0.011*	0.057
Total MVPA	11.89	0.008*	0.061
Vigorous total daily	7.39	0.060	0.038

Notes:* $p<0.05$ indicates statistically significant physical activity differences. Effect size (η^2H): 0.01-0.06 small, 0.06-0.14 medium, ≥0.14 large).

Health correlates of physical activity

The relationships between health indicators and physical activity showed that self-rated health was positively correlated with MPA and VPA. Statistically significant, though moderately weak, correlations were observed for:

- MPA (ρ=-0.153, p=0.032, 95% CI [-0.29; -0.01]),
- VPA (ρ=-0.172, p=0.016, 95% CI [-0.31; -0.03]),
- Total MVPA (ρ=-0.155, p=0.029).

These results indicate that individuals with higher self-rated health exhibited higher levels of physical activity in the MVPA range, and those with higher levels of such activity rated their health more favorably. In contrast, for BMI, significant correlations were found with LPA (ρ=0.158, p=0.028). This inverse relationship suggests that a higher BMI is associated with a lower level of physical activity. No significant associations were observed between BMI and MVPA (Tables 5 and 6).

Table 5. Spearman's rank correlations between health correlates and physical activity in the study group

Health correlates	Sedentary	LPA	MPA	VPA	Total MVPA
General health	0.090	-0.046	-0.153*	-0.172*	-0.155*
BMI	-0.162*	0.158*	0.024	-0.070	0.011

Notes: Values are Spearman's rank correlation coefficients (ρ) * p<0.05.

Table 6. Country-specific associations between health correlates and physical activity

Country	Health correlates	Activity variable	ρ	*p*	95% CI
Czech Republic (n=50)	**General health**	**MPA**	-0.101	0.484	[-0.376, 0.190]
		VPA	-0.039	0.788	[-0.322, 0.250]
		Total MVPA	-0.089	0.540	[-0.366, 0.203]
	BMI	**MPA**	0.262	0.066	[-0.026, 0.510]
		VPA	-0.088	0.542	[-0.365, 0.203]
		Total MVPA	0.243	0.089	[-0.046, 0.495]
Hungary (n=43)	**General health**	**MPA**	-0.267	0.084	[-0.532, 0.046]
		VPA	-0.373	0.014*	[-0.611, -0.073]
		Total MVPA	-0.289	0.060	[-0.549, 0.021]
	BMI	**MPA**	-0.142	0.374	[-0.439, 0.182]
		VPA	-0.056	0.727	[-0.366, 0.265]
		Total MVPA	-0.156	0.330	[-0.450, 0.169]
Poland (n=49)	**General health**	**MPA**	0.069	0.640	[-0.225, 0.351]
		VPA	-0.124	0.394	[-0.399, 0.171]
		Total MVPA	0.054	0.714	[-0.239, 0.337]
	BMI	**MPA**	-0.060	0.683	[-0.343, 0.233]
		VPA	-0.182	0.210	[-0.448, 0.113]
		Total MVPA	-0.107	0.464	[-0.384, 0.188]
Slovakia (n=55)	**General health**	**MPA**	-0.190	0.165	[-0.440, 0.087]
		VPA	-0.028	0.841	[-0.298, 0.247]
		Total MVPA	-0.137	0.319	[-0.395, 0.141]
	BMI	**MPA**	0.042	0.765	[-0.239, 0.316]
		VPA	0.147	0.292	[-0.136, 0.409]
		Total MVPA	0.088	0.529	[-0.194, 0.358]

Notes: Spearman's ρ values represent correlations between accelerometer-measured physical activity and health correlates (BMI and self-rated general health). * p<0.05 indicates statistical significance.

All the above relationships confirm a typical epidemiological pattern: (1) better subjective health is associated with higher levels of physical activity, particularly in the moderate and vigorous intensity ranges; (2) a lower BMI is associated with higher levels of physical activity.

Discussion

This study presents findings on students' physical activity levels in Central and Eastern Europe, based on 7-day monitoring with ActiGraph GT3X+ accelerometers. The use of accelerometry enabled an objective assessment and comparison of current movement behavior patterns among university students from the four V4 countries: the Czech Republic, Hungary, Poland, and Slovakia, and allowed for the results to be referenced against data from other countries to identify differences and dominant types of activity in young adult populations [24,25].

The results showed that the students' physical activity was high, particularly in LPA and MPA activity, with little VPA. Previous accelerometer-based studies among young adults have reported MPA levels of 30-50 minutes per day and only a few minutes of VPA [26,27]. Our results indicate slightly higher values but follow a similar trend. Thus, we confirmed that the activity patterns of V4 university students in terms of the WHO-recommended MVPA are characterized by the same feature observed in student samples from other European countries: a small proportion of VPA within total MVPA [28,29].

Our study revealed significant differences in physical activity levels among students from the individual V4 countries, which may be determined by understood cultural, natural, and anthropogenic environmental factors [30].

The results of correlation analyses between physical activity levels and basic health indicators did not show unequivocal relationships, which is also confirmed in literature. Self-rated health among young adults is a variable strongly modulated by psychosocial factors (e.g., stress, educational burden), and its association with objectively measured physical activity tends to be weak or moderate [31,32]. The lack of statistically significant associations between BMI and physical activity in young adults has also been demonstrated in both European and American studies [26]. Nevertheless, weak and often insignificant correlations between physical activity indicators and self-rated health and BMI should be interpreted with caution and not taken as evidence that physical activity is irrelevant to students' health. Most likely, they reflect the relative homogeneity of this young and predominantly healthy population and, perhaps more importantly, the limited sensitivity of basic health indicators to the early, subclinical effects of inactivity. Furthermore, as results on sedentary lifestyle were not included in these analyses, further research using robust 24-hour physical activity protocols is needed.

The results presented in this article include another interesting element that is difficult to obtain in survey-based studies, namely, data on LPA, which in our research constituted the most critical component in the daily composition of physical activity. Although this type of activity is not included in the WHO guidelines, numerous publications confirm its unquestionable health benefits, especially in young adults who spend many hours "at their desks" [33,34]. The health benefits of MVPA are, of course, indisputable; however, a prominent level of LPA promotes improved metabolic health and is associated with a better cardiovascular profile, which can be considered a favorable trend observed among V4 students.

It is also worth emphasizing that when interpreting data on MPA, VPA, and MVPA, their compositional nature should be considered – an increase in one component must occur at the expense of another [35]. In our study, strong positive correlations between the various intensity ranges are consistent with this logic and align with recommended 24-hour movement behavior models.

In our study, which used accelerometers to measure physical activity, we obtained new and valuable data on students' movement behaviors in V4 countries. To better understand the results, we compared them with previous studies conducted in the Czech Republic, Hungary, and Slovakia. In recent years, these countries have seen a clear development of physical activity monitoring methods, although studies involving students, especially those using accelerometers, remain scanty.

In the Czech Republic, most studies have focused on school-aged youth and young adults. Our observations regarding the prominent level of LPA among Czech students are consistent with the findings of Frömel et al., who analyzed the relationship between academic stress and physical activity [22]. Their work showed that Czech students are moderately active, although VPA is rare, as in our findings. Bergier et al., using the IPAQ questionnaire, observed that Czech students report higher levels of physical activity than their peers from other V4 countries, which may explain the high LPA values obtained in our study [19]. The study by Voráček et al., involving a large group of students, confirmed that most meet general physical activity recommendations, but only a small proportion regularly engage in vigorous exercise [36]. Our results, obtained using a uniform protocol, confirm that Czech students are sufficiently active daily, although their activity is most often of low or moderate intensity.

The Hungarian students in our sample achieved the highest MVPA values among all analyzed groups. This finding is supported by an increasing number of Hungarian studies based on objective measurements. The work of Ács et al., which focused on validating the IPAQ questionnaire against accelerometer data, provided important comparative data [20]. The authors noted that self-assessment may lead to overestimation of MVPA, highlighting the importance of direct measurements. Pósa et al. demonstrated that physical activity among young adults in Hungary is strongly related to health attitudes and social support, which may partly explain the higher results in our group [37]. Our observations are consistent with this trend, while also allowing for precise international comparisons of MVPA levels.

In Slovakia, as in neighboring countries, the physical activity monitoring system is gradually developing. The study by Frömel et al., which also included Slovak adolescents, showed that physical activity levels are linked to school conditions [22]. Transferring these findings to the academic environment, it can be assumed that the availability of sports facilities, the range of physical activity classes, and university policies have a significant impact on student behavior. In our sample, Slovak students achieved intermediate LPA and MVPA values, positioning themselves between students from Hungary and Poland. Evidence from Slovakia suggests that the transition to university is accompanied by lifestyle changes that include reduced physical activity and frequent sitting, indicating that sedentary patterns may remain a relevant behavioural component in Slovak student populations [38]. Other studies using accelerometers also indicate a small proportion of vigorous activity in total movement time, which is consistent with our findings for all V4 countries [29]. Slovak students represent a regional "average" in terms of movement behaviors, which may result from complex cultural and infrastructural determinants.

In summary, comparing our results with the research output from V4 countries over the past several years allows us to draw several important conclusions. First, across all analyzed countries, the share of VPA in students' daily movement profiles is small, consistent with global trends among young adults. In the V4 region, this may be related to a similar educational model that promotes prolonged sitting and limits spontaneous activity outside of physical education classes. Second, the results from individual countries create a coherent regional picture: Hungary stands out with higher activity, Poland with lower, and the Czech Republic and Slovakia occupy intermediate positions. Third, our study, thanks to its uniform methodology, provides a solid basis for international comparisons and allows for the verification of conclusions from previous, often fragmented, national studies.

Strengths and limitations

The present material is the first accelerometer-based study of physical activity conducted in Central and Eastern Europe among university students from the V4 countries. The study employed not only objective measurements but also a standardized procedure across all countries, enabling direct comparison of students' movement behaviors. Additionally, two practical health indicators – BMI and self-rated health – were included in the correlation analyses. This allowed for a multifaceted analysis of the relationships between movement behaviors and the overall health status of young adults.

However, the study is not without certain limitations. One of the most important is the unequal sample sizes in the individual countries, especially when considering the division by biological sex. Additionally, the observed differences in physical activity levels among the V4 countries may, at least in part, stem from distinct cultural and environmental conditions, including local leisure-time activity patterns, the availability of sports facilities, and urban design features that support active transportation. Moreover, the structure and organization of the academic day may also influence students' daily physical activity levels. A further limitation is the potential Hawthorne effect [39] (i.e., participants' mere awareness of wearing an accelerometer), which may have prompted some individuals to temporarily increase their physical activity, potentially leading to an overestimation of habitual MVPA. Finaly, the analyses used only basic health indicators without including biomarkers or other health-related parameters that could provide a more comprehensive picture of the health determinants among students. These limitations should be addressed in future, preferably longitudinal, studies.

Conclusions

In this multi-country sample of university students from the V4 region, objectively measured physical activity levels were generally high, and statistically significant differences in physical activity among students from the individual V4 countries were reviled. The highest MVPA values were seen in the group of Hungarian students, while the lowest were observed among Polish students. The relationships between physical activity, BMI, and self-rated health, even when statistically significant, proved to be weak. This result suggests that among young adults, differences in physical activity do not translate strongly enough into measurable health indicators.

The results also showed considerable daily variability in physical activity, which may be crucial for long-term health prevention. The study also highlights the need for longitudinal research to determine whether the observed movement behavior profiles persist into later adulthood and how they affect metabolic, functional, and mental health at this stage of life.

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