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Adherence to the 24-hour movement guidelines among university students in the Visegrad Group countries: a cross-sectional study

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Abstract

Background. The 24-hour movement behavior (24HMB) framework integrates physical activity, sedentary behavior, and sleep into a single health paradigm. University students are known to be vulnerable to inadequate movement patterns. However, no previous study has compared adherence to the 24HMB guidelines across the Visegrad Group (V4) countries (Czech Republic, Hungary, Poland, Slovakia).

Material and methods. This cross-sectional study included 2,611 university students aged 18-29 years. Movement behaviors were assessed using the International Physical Activity Questionnaire – Long Form (IPAQ-LF) and self-reported sleep duration. Guidelines adherence was defined as meeting all three components: ≥150 minutes/week of moderate-to-vigorous physical activity (MVPA), ≤8 hours/day of sedentary time, and ≥7 hours of sleep. Descriptive statistics and Chi-square tests were applied to examine gender and country differences using IBM SPSS 29.0 software.

Results. Overall, 44.24% of students met the physical activity guideline, 82.27% met the sedentary behavior guideline, and 85.43% met the sleep guideline. Only 26.92% adhered to all three 24HMB recommendations. Significant differences were observed across countries for physical activity (p<0.001) and sleep (p=0.025), but not for sedentary time or full adherence.

Conclusions. Adherence to the integrated 24HMB guidelines is low among V4 university students, highlighting the need for coordinated, context-specific interventions.

Keywords: Visegrad, IPAQ-LF, physical activity, adherence, students

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Introduction

Recently, the concept of 24-hour movement behavior (24HMB) has attracted increasing attention in the field of public health. These comprehensive guidelines emphasize the interconnection between physical activity, sedentary behavior, and sleep within a single day, recognizing their combined influence on both physical and mental health. Unlike traditional recommendations that address each behavior individually, the 24-hour movement guidelines offer a holistic approach to improving health throughout a person's life [1-3].

The 24HMB model integrates physical activity, sedentary behavior, and sleep into a comprehensive framework. It recommends that adults engage in at least 150 minutes of moderate to vigorous exercise weekly, limit sedentary activities, particularly screen time, to no more than 8 hours a day, and ensure they get 7 to 9 hours of quality sleep each night. However, university students often struggle to meet these guidelines due to irregular schedules, academic demands, and lifestyle changes, leading to insufficient physical activity, prolonged sedentary behavior, and poor sleep hygiene. Studies show that only about 40-50% of university students worldwide meet the recommended levels of physical activity, with even lower rates in some European countries. For instance, a recent study of Central European university students found that over 60% exceeded the recommended daily screen time, and more than 45% reported inadequate sleep duration on school nights. Additionally, students' sedentary behavior can exceed 9-10 hours daily, especially during exam periods, while their physical activity levels tend to decline steadily throughout their university years. These trends highlight the growing importance of integrated lifestyle monitoring and early intervention for this vulnerable group [4-9].

Increasing evidence suggests that following 24-hour movement guidelines is associated with numerous positive outcomes, including enhanced cardiometabolic health, better mental well-being, improved cognitive function, and higher academic performance. In contrast, straying from these guidelines, like engaging in excessive sedentary behavior and getting insufficient sleep, is associated with a heightened risk of obesity, depression, and chronic illnesses in the future [4,10-11]. These findings highlight the necessity of addressing all three movement behaviors collectively rather than separately. The period of young adulthood, especially during university years, is a crucial time when lifelong health habits are formed. Although young adults often gain more independence and flexibility, they also face new stressors, social pressures, and time limitations that can adversely affect their physical activity, screen time, and sleep habits. Research from various countries has shown that a large number of university students do not meet movement recommendations; however, few studies have explored these behaviors through the comprehensive perspective of the 24-hour movement framework [2,7-9].

In Central and Eastern Europe, the Visegrad Group (V4) countries – the Czech Republic, Hungary, Poland, and Slovakia – share several socio-cultural and historical characteristics; however, public health surveillance and movement behavior research remain fragmented. National-level monitoring of physical activity and sleep is inconsistent, and data on sedentary

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time are particularly limited [12]. Moreover, cross-country comparisons using standardized metrics are rare, and there is little understanding of how socioeconomic, academic, and cultural factors may influence adherence to movement guidelines in this region. Concerning movement behavior, various studies suggest that the physical activity habits of university students in the V4 countries are influenced by both common regional traits and unique national circumstances. While a general reduction in activity is typically observed as students transition from high school to university due to increased independence, academic demands, and reduced institutional support, the degree and nature of this reduction differ across regions. In Hungary, for instance, some metrics have shown an improvement in students' participation in sports in recent years. Conversely, in Slovakia, Poland, and the Czech Republic, research indicates a more significant drop in physical activity levels, particularly linked to the COVID-19 pandemic and its consequences. These varying patterns imply that, despite the V4 countries' shared socio-economic and educational backgrounds, national public health policies, availability of sports facilities, and cultural perceptions of exercise play a crucial role in shaping university students' physical activity behaviors [13-17].

Exploring these gaps and gaining a more profound understanding of how university students in the V4 countries engage in physical activities, sedentary behaviors, and sleep within the 24-hour movement framework could help in developing more targeted and culturally appropriate health promotion strategies. By identifying common patterns and national differences, this research could also aid in formulating unified interventions and public health messages across the region.

Aim of the work

The study aimed to assess the prevalence and patterns of adherence to the 24-hour movement guidelines among university students in the V4 countries and to explore potential differences and similarities in their movement behavior profiles.

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Material and methods

Study design and setting

This cross-sectional study evaluated adherence to the 24HMB guidelines among university students in the V4 countries: Hungary, Poland, Slovakia, and the Czech Republic. Data collection was conducted in collaboration with partner universities: University of Pécs (Hungary), John Paul II University in Biała Podlaka (Poland), Pavol Jozef Šafárik University in Košice (Slovakia), and University of South Bohemia in České Budějovice (Czech Republic). Each institution was responsible for local participant recruitment, questionnaire administration, and obtaining ethical approval through their respective Bioethics Commissions.

Participants

Participants were recruited through non-randomized convenience sampling. The inclusion criteria stipulated that respondents be between 15 and 29 years of age, currently enrolled as active university students, and native speakers of the respective national language. Students with medical or psychological conditions that could significantly impact movement behaviors were excluded. The initial target sample size was set at a minimum of 500 participants per country. In total, 2,697 university students completed the survey, and 2,611 were included in the final analysis. Respondents under the age of 18 and those who did not indicate the country of questionnaire completion, or those who provided an incomplete physical activity questionnaire, were removed from the final dataset.

Measurement tools

Sociodemographic and health-related characteristics included gender, age, country, field of study, and self-rated health. Body Mass Index (BMI) was calculated from self-reported body weight (kg) and height (cm).

Movement behaviors were assessed using the International Physical Activity Questionnaire – Long Form (IPAQ-LF), a validated self-report tool capturing physical activity across four domains: (1) occupational, working activity, (2) transport-related activity (e.g. walking, cycling) – active transportation, (3) domestic and gardening tasks, and (4) leisure-time

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physical activity. Participants reported the frequency and duration of activities during the previous seven days. Moderate-to-vigorous physical activity (MVPA) was calculated following the standard IPAQ scoring protocol. Weekly minutes total scores were calculated for each domain [18].

Sedentary behavior was measured through IPAQ-LF items on average weekday and weekend sitting time. A weighted mean (5 weekdays and 2 weekend days) was used to estimate overall daily sedentary time.

Sleep duration was assessed using a custom item that asked students to report their typical sleep duration on weekdays and weekend days. From these values, an average daily sleep duration was derived.

All movement behavior indicators were harmonized according to the 24HMB recommendations. Participants were classified as meeting the guideline thresholds if they accumulated at least 150 minutes of leisure-time MVPA per week, spent fewer than 8 hours per day in sedentary behavior, and reported an average daily sleep duration minimum 7 hours, in accordance with the Canadian 24-Hour Movement Guidelines [19].

Statistical analysis

Data processing and statistical analyses were performed using IBM SPSS Statistics software version 29.0. Descriptive statistics were used to summaries participant characteristics and determine adherence rates to individual 24HMB guideline components. Chi-square tests were assessed to examine the gender and country differences. Statistical significance was set at $p<0.05$.

Results

The final sample (n=2,611) predominantly comprised female students (72.81%), with male students constituting 27.19% of the respondents. Participants were distributed across the four V4 countries, with the largest proportion enrolled in Hungary (34.51%), followed by Czech Republic (24.97%), Slovakia (22.52%), and Poland (18.00%). The mean age of the participants was 21.45 years (SD=2.22). The average BMI was 23.19 kg/m² (SD=4.24), indicating that most students were within the normal weight range. Regarding weight control behavior, nearly half of the students reported satisfaction with their current weight and did not engage in weight

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control activities (45.54%). Approximately one-quarter of the sample reported active efforts to control their weight (25.70%), while 18.61% expressed a need to lose weight but had not taken action. A smaller proportion (10.15%) reported a need to gain weight. Body image perceptions revealed that more than half of the respondents considered their body size to be "about the right size" (52.24%). Approximately one-quarter perceived themselves as "a little too fat" (26.20%), while 4.90% felt they were "too fat". Conversely, 14.29% viewed themselves as "a little too thin", and 2.37% as "too thin" (Table 1).

Table 1. Descriptive characteristics of the study population (n=2,611)

Variable		n	%
Gender	**Female**	1901	72.81
	Male	710	27.19
Country	**Czech Republic**	652	24.97
	Hungary	901	34.51
	Poland	470	18.00
	Slovakia	588	22.52
Weight control	**No, my weight is ok**	1189	45.54
	No, but I should lose weight	486	18.61
	No, because I need to gain weight	265	10.15
	Yes	671	25.70
Body image	**Too thin**	62	2.37
	A little too thin	373	14.29
	About the right size	1364	52.24
	A little too fat	684	26.20
	Too fat	128	4.90
Age	**Mean (SD)**	21.45	2.22
BMI	**Mean (SD)**	23.19	4.24

Across the four countries, a significant difference was observed in the proportion of university students meeting the physical activity guideline (χ^2=18.080, p<0.001). Gender differences were not significant (p=0.165), although a slightly higher proportion of males met the guideline across all countries. Overall, 44.24% of the sample met the recommended level of daily physical activity. Compliance was highest in Hungary (49.05%), followed by Poland (46.06%), Slovakia (40.82%), and the Czech Republic (39.38%) (Table 2).

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Table 2. Physical activity guideline compliments of the university students of the V4 countries (n=2,611)

Physical activity guideline		Country								Total		Chi-square	*p*
		Czech Republic		Hungary		Poland		Slovakia					
		n	%	n	%	n	%	n	%	n	%		
Female	Does not meet	311	61.10	395	51.57	165	54.64	204	63.16	1075	56.58	18.224	<0.001
	Meets	198	38.90	371	48.43	137	45.36	119	36.84	825	43.42		
	Total	509	100.00	766	100.00	302	100.00	323	100.00	1900	100.00		
Male	Does not meet	83	58.87	63	47.37	88	52.69	144	54.34	378	53.54	3.760	0.289
	Meets	58	41.13	70	52.63	79	47.31	121	45.66	328	46.46		
	Total	141	100.00	133	100.00	167	100.00	265	100.00	706	100.00		
Total	Does not meet	394	60.62	458	50.95	253	53.94	348	59.18	1453	55.76	18.080	<0.001
	Meets	256	39.38	441	49.05	216	46.06	240	40.82	1153	44.24		
	Total	650	100.00	899	100.00	469	100.00	588	100.00	2606	100.00		
Chi-square/*p*		0.231	0.631	0.799	0.371	0.163	0.686	4.686	0.030	1.926	0.165	-	-

The distribution of adolescents reporting more than 8 hours of daily sitting time did not differ significantly between countries (χ^2=5.366, p=0.147). Overall, 18.73% of participants exceeded the 8-hour threshold. Prevalence was lowest in the Czech Republic (15.47%) and in Slovakia (16.08%) and highest in Poland (19.82%). No significant gender differences emerged (p=0.405), although females consistently reported slightly more sedentary time (Table 3).

Table 3. Sitting time guideline compliments of the university students of the V4 countries (n=2,611)

Sitting time		Country								Total		Chi-square	*p*
		Czech Republic		Hungary		Poland		Slovakia					
		n	%	n	%	n	%	n	%	n	%		
Female	≤8 h	424	86.35	595	81.06	235	80.76	257	82.37	1511	82.66	6.736	0.081
	>8 h	67	13.65	139	18.94	56	19.24	55	17.63	317	17.34		
	Total	491	100.00	734	100.00	291	100.00	312	100.00	1828	100.00		
Male	≤8 h	106	76.81	104	79.39	121	79.08	223	85.77	554	81.23	6.034	0.110
	>8 h	32	23.19	27	20.61	32	20.92	37	14.23	128	18.77		
	Total	138	100.00	131	100.00	153	100.00	260	100.00	682	100.00		
Total	≤8 h	530	84.26	699	80.81	356	80.18	480	83.92	2065	82.27	5.366	0.147
	>8 h	99	15.74	166	19.19	88	19.82	92	16.08	445	17.73		
	Total	629	100.00	865	100.00	444	100.00	572	100.00	2510	100.00		
Chi-square/*p*		7.397	0.007	0.201	0.654	0.176	0.675	1.213	0.271	0.693	0.405	-	-

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Sleep duration showed substantial between-country variation (χ^2=9.388, p=0.025). In the pooled sample, 85.43% of university students reported sleeping at least 7 hours per night. Adequate sleep was most prevalent in the Czech Republic (87.94%), followed by Poland (84.09%) and Slovakia (82.10%). Gender differences were not significant (p=0.985) (Table 4).

Table 4. Sleeping time of the university students of the V4 countries (n=2,611)

Sleeping time		Country								Total		Chi-square	*p*
		Czech Republic		Hungary		Poland		Slovakia					
		n	%	n	%	n	%	n	%	n	%		
Female	<7 h	46	11.68	75	12.63	50	18.12	57	19.00	228	14.58	11.968	0.007
	≥7 h	348	88.32	519	87.37	226	81.88	243	81.00	1336	85.42		
	Total	394	100.00	594	100.00	276	100.00	300	100.00	1564	100.00		
Male	<7 h	15	13.39	16	15.09	17	11.72	40	16.53	88	14.55	1.840	0.606
	≥7 h	97	86.61	90	84.91	128	88.28	202	83.47	517	85.45		
	Total	112	100.00	106	100.00	145	100.00	242	100.00	605	100.00		
Total	<7 h	61	12.06	91	13.00	67	15.91	97	17.90	316	14.57	9.388	0.025
	≥7 h	445	87.94	609	87.00	354	84.09	445	82.10	1853	85.43		
	Total	506	100.00	700	100.00	421	100.00	542	100.00	2169	100.00		
Chi-square/*p*		0.243	0.622	0.484	0.486	2.902	0.088	0.557	0.456	0.000	0.985	-	-

Compliance with the integrated 24HMB guideline (sufficient physical activity, ≤8 h sitting, and ≥7 h sleep) was relatively low and did not differ significantly across countries (χ^2=3.279, p=0.351). Only 26.92% of university students met all components, with the highest compliance in Hungary (28.63%) and the lowest in the Czech Republic (24.69%). Czech, Hungarian, and Slovak males exhibited higher compliance compared with females. Gender differences were not significant (p=0.203) in the V4 countries, although males tended to have slightly higher compliance in several countries (Table 5).

Table 5. Compliment of the 24HMB of the university students of the V4 countries (n=2,611)

24HMB		Country								Total		Chi-square	*p*
		Czech Republic		Hungary		Poland		Slovakia					
		n	%	n	%	n	%	n	%	n	%		
Female	Does not meet	384	75.44	551	71.84	218	72.19	249	77.09	1402	73.75	4.444	0.217
	Meets	125	24.56	216	28.16	84	27.81	74	22.91	499	26.25		
	Total	509	100.00	767	100.00	302	100.00	323	100.00	1901	100.00		
Male	Does not meet	107	74.83	92	68.66	122	72.62	185	69.81	506	71.27	1.754	0.625

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	Meets	36	25.17	42	31.34	46	27.38	80	30.19	204	28.73		
	Total	143	100.00	134	100.00	168	100.00	265	100.00	710	100.00		
Total	**Does not meet**	491	75.31	643	71.37	340	72.34	434	73.81	1908	73.08	3.279	0.351
	Meets	161	24.69	258	28.63	130	27.66	154	26.19	703	26.92		
	Total	652	100.00	901	100.00	470	100.00	588	100.00	2611	100.00		
Chi-square/*p*		0.023	0.880	0.565	0.452	0.010	0.920	3.989	0.046	1.620	0.203	-	-

Discussion

This study provides novel evidence on the 24HMB among university students in the V4 countries. Several studies have examined physical activity levels among children, adolescents, and youth; however, evidence from the V4 countries remains limited and fragmented regarding 24HMB among university students [20-23]. To date, no prior research has reported the prevalence of full adherence to the 24HMB guidelines among V4 university populations, highlighting the relevance and originality of the present findings. Our results show that only 26.2% of students met all three recommendations: sufficient physical activity, ≤8 hours of sitting time, and ≥7 hours of sleep, indicating substantial gaps in daily movement health within this population.

The proportion of students meeting the physical activity guideline (44.24%) aligns with findings from previous international studies. Irwin reported that fewer than 50% of university students in the United States and Canada met recommended physical activity levels, with somewhat higher values observed in Australia (60%) [24]. Similarly, Sarkin et al. noted substantial variability in physical activity prevalence (32-59% for fitness-based guidelines and 4-70% for health-related guidelines), largely due to measurement instruments and scoring protocols [8]. The prevalence identified in our V4 sample falls within these ranges, confirming that university students worldwide experience comparable challenges in maintaining recommended activity levels. No significant gender differences were observed in physical activity adherence, which is consistent with emerging evidence that sex-specific differences tend to narrow during young adulthood, possibly due to shared academic stressors, social norms, and lifestyle patterns. Although earlier studies identified lower physical activity levels among female students in certain regions, this pattern was not evident in our sample.

Sedentary behavior showed no significant gender or country differences in our study, with 17.7% of students exceeding 8 hours of daily sitting. This prevalence is lower than that reported in the systematic review and meta-analysis by Castro et al. [7], which concluded that

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university students are generally highly sedentary and that sitting time has increased over the past decade. A likely explanation is methodological: Castro et al. [7] found that accelerometer-based sedentary time is substantially higher than self-reported estimates. Given that sitting time in our study was self-reported, it is plausible that actual sitting time is underestimated. The lack of demographic variability is consistent with evidence that sedentary patterns among university students are strongly shaped by academic tasks, digital learning platforms, and screen-based behaviors, which tend to be similar across sexes and institutional settings [7,25].

More than 85% of students reported sleeping at least 7 hours per night; however, significant differences emerged across countries, with the Czech Republic showing the most favorable sleep duration and Slovakia the least. Previous literature has highlighted a lack of university-specific prevalence data for sleep within a 24HMB framework. Therefore, the current findings provide important baseline information. The absence of gender differences mirrors broader evidence suggesting that sleep behaviors among university students are driven more by contextual factors, such as academic load, commuting patterns, and living arrangements than by biological sex [26-27].

Consistent with early evidence from non-university adult samples, adherence to the full 24HMB guideline was considerably lower than adherence to any single behavior. López-Gil et al. reported low overall compliance with 24HMB guidelines in the general adult population, corroborating the difficulty of meeting all components simultaneously [9]. In our study, neither gender nor country significantly predicted full adherence, indicating that the challenge of integrating activity, sitting, and sleep behaviors is ubiquitous across demographic subgroups and national contexts within the V4 region.

These findings highlight the need for integrated, rather than behavior-specific, health promotion strategies in university settings. Focusing solely on physical activity, for example, may be insufficient if sedentary behavior remains high or sleep duration inadequate. Furthermore, the adherence to the whole complete set of 24HMB guidelines, combining sufficient physical activity, limited sitting time and screen time, and adequate sleep, was associated with improved bone mineral density in youth and children [28] and better mental health status [29-31].

In our study, several limitations must be acknowledged. First, the cross-sectional study design prevents causal interpretation of the relationships among the movement behaviors. Longitudinal studies are needed to examine behavioral trajectories and potential bidirectional effects. Furthermore, the non-randomized sampling limits the representativeness of the sample

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and may affect generalizability to broader university populations in the V4 countries. Participation bias cannot be ruled out, as students with a stronger interest in health behaviors may have been more likely to respond. Finally, all movement behaviors were assessed using self-report instruments, which are susceptible to recall and social desirability bias. Prior research has demonstrated considerable discrepancies between self-report and objective measures, particularly for sedentary behavior and physical activity. Despite these limitations, the study provides valuable, previously unavailable evidence on 24HMB adherence among university students in the V4 region and contributes meaningfully to an understudied area.

The findings of this study highlight the concerningly low adherence to the 24HMB guidelines among university students in the V4 countries. Despite the growing recognition of the importance of integrating physical activity, sedentary behavior, and sleep into a unified health framework, only a small proportion of participants met all three recommended components. This aligns with earlier research indicating that young adults, particularly university students, are at risk of imbalanced lifestyle behaviors due to academic pressure, irregular daily schedules, and increased screen exposure.

Conclusions

This study offers the first comprehensive assessment of adherence to the 24HMB among university students in the V4 countries. The findings reveal substantial gaps between recommended and actual behavioral patterns, with only one in four students meeting all three components, physical activity, sedentary behavior, and sleep, simultaneously. Although significant differences were observed across countries in physical activity and sleep, no gender differences emerged for any movement behavior, and adherence to the integrated 24-hour guideline did not differ significantly between countries. These results suggest that structural, institutional, and environmental influences may be more important determinants of movement behavior than demographic characteristics within this population. The low overall adherence highlights an urgent need for coordinated, context-specific, and 24-hour-based health promotion strategies in university settings. Efforts should emphasize not only increasing physical activity but also reducing sedentary time and promoting healthy sleep.

Future studies should incorporate objective measurement tools and longitudinal designs and inform tailored interventions that support healthier daily routines among university students.

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