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Integrated 24-hour movement behavior as a key correlate of life satisfaction among university students in the Visegrad Group countries

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Abstract

Background. Physical activity contributes to physical and psychological well-being, yet the role of combined daily movement behaviors in shaping life satisfaction among emerging adults remains insufficiently understood. The V4More study examined associations between 24-hour movement behavior (24hMB), sport participation, and lifestyle among university students in the Visegrad Group (V4) countries.

Material and methods. A cross-sectional, quota-based sample of 2,611 students aged 18-29 years was analyzed across Hungary, Poland, Slovakia, and the Czech Republic. Physical activity and sedentary behavior were assessed using IPAQ-LF, while sport participation, sleep, and BMI were self-reported. Life satisfaction was measured using the Cantril Ladder. A composite 24hMB captured adherence to recommendations for physical activity, sedentary time, and sleep. Hierarchical linear regression identified predictors of life satisfaction.

Results. Mean life satisfaction was moderate (6.71±1.62). Only 26.9% met 24hMB guidelines, while 86.8% sat more than eight hours daily. In regression analysis, 24hMB was the strongest behavioral predictor (β=0.100, $p<0.001$), followed by weekly sport participation (β=0.098, $p<0.001$). BMI showed a negative association (β=-0.105, $p<0.001$).

Conclusions. Balanced 24hMB and regular sport engagement are modest but meaningful correlates of life satisfaction among V4 students. Findings support whole-day movement promotion focusing on activity, reduced sitting, and healthier sleep routines.

Keywords: V4 countries, life satisfaction, university students, sports, physical activity

Introduction

Physical activity (PA) is widely recognized as a determinant of both physical and psychological well-being, with evidence consistently showing its role in supporting women's health across the life course [1] and in promoting favorable mental health outcomes [2]. Beyond its somatic benefits, PA contributes to psychological functioning by fostering autonomy, intrinsic motivation, and health-oriented goal pursuit, factors that collectively enhance life satisfaction [3]. Life satisfaction itself is a central dimension of subjective well-being, reflecting individuals' cognitive evaluation of their life circumstances [4]. Low life satisfaction is

associated with heightened risks of depression, anxiety, and neuroticism [5], as well as poorer physical health, morbidity, and mortality [6].

Accumulating evidence suggests that physically active individuals report higher levels of life satisfaction and better overall functioning in daily life [7,8]. Even short-term engagement in structured exercise can elevate subjective well-being, particularly among previously inactive individuals [9]. PA has shown stronger associations with positive mental well-being than physical performance indicators such as muscular strength or gait speed, underscoring the broader psychosocial value of activity beyond physiological capacity [10]. Similar patterns extend to sports participation, which has been linked to enhanced life satisfaction and perceived health status in diverse populations [11].

More recently, research has shifted from examining isolated health behaviors towards integrative frameworks that consider PA, sedentary behavior, and sleep as interdependent components of a 24-hour cycle. The 24-hour movement behavior (24hMB) paradigm reflects this holistic perspective and has been increasingly adopted in public health research; however, its application to subjective well-being outcomes remains limited. In particular, evidence on how integrated daily movement patterns relate to life satisfaction among young adults is still scarce.

Within university student populations, particularly in the Visegrad Group (V4) countries, these relationships merit closer examination. Young adults often experience substantial lifestyle transitions, including increased sedentary behavior, academic pressure, and psychosocial stress, all of which may compromise subjective well-being. Despite growing interest in student mental health, most existing studies in this population focus on single behavioral indicators (e.g. total PA or sport participation), while the combined role of activity, sedentary time, and sleep is rarely explored. Moreover, comparative evidence from Central and Eastern European countries, including the V4, remains underrepresented in international literature. Understanding how different types and intensities of PA relate to life satisfaction in this context is therefore essential. Existing evidence suggests that not all forms of activity yield equivalent psychological benefits; leisure-time, self-directed, and vigorous activities may be more closely tied to well-being than obligatory or work-related physical effort.

Aim of the work

Building on this framework, the present study examines the associations between PA patterns and life satisfaction among university students across four Central European countries. By explicitly adopting an integrated 24hMB approach, this study addresses an important gap in literature by moving beyond single-behavior models and examining how the balance of daily movement behaviors relates to life satisfaction. By combining a large, multinational sample from the V4 countries with a public health-oriented perspective, the study aims to contribute novel evidence on the relevance of whole-day movement patterns for subjective well-being during a critical period of emerging adulthood.

Material and methods

Study design and sampling

The study followed the STROBE recommendations for cross-sectional observational research [12]. A quota-based cross-sectional design was applied, accounting for age, gender, and educational level. In total, 500 university students aged 18-29 years were recruited from each of the V4 countries (Hungary, Poland, Slovakia, and the Czech Republic). Eligibility criteria included active enrolment in higher education and the absence of medical or psychological conditions that could limit mobility or cognition.

For the full analytical dataset, life satisfaction and movement-related variables (sport participation, PA, sedentary time, sleep) and sociodemographic and anthropometric variables were available for 2,611 students, forming the basis of all statistical analyses.

Measures

PA and sedentary behavior were assessed using the validated International Physical Activity Questionnaire – Long Form (IPAQ-LF), which captures activity across four domains and daily sitting time [13,14]. Additional self-reported measures included sport participation in regard to frequency (days/week) and the purpose of sport participation (competition or recreation), consistent with prior youth and university-level activity surveillance approaches.

Life satisfaction was evaluated using a ladder-type scale. The Cantril Ladder (Self-Anchoring Striving Scale) is a simple visual 0-10 scale on which respondents evaluate their current life satisfaction by imagining the best and worst possible life circumstances [15]. This method is widely used in international well-being research, particularly among youth and adolescent populations, including in large-scale surveys such as the HBSC Study [16] and UNICEF well-being assessments [17].

To evaluate guidelines adherence, we also constructed an integrated 24hMB indicator, capturing whether students simultaneously met recommended thresholds for PA, sedentary time, and sleep. This approach aligns with the 24-hour movement guidelines emphasizing the interdependence of activity, sedentary behavior, and sleep for optimal health [18]. This variable formed the primary behavioral predictor in the regression models. Weekly sport participation was derived as a continuous measure (days/week). Body mass index (BMI) was calculated from self-reported weight and height. Gender, age, and academic characteristics were included as covariates.

Statistical analysis

Descriptive statistics summarized participant characteristics. After the Kolmogorov-Smirnov normality test, group differences across countries and sociodemographic categories were tested using the Kruskal-Wallis H and the Mann-Whitney U test.

Associations between movement-related behaviors and life satisfaction were examined using Spearman correlation analyses.

To identify the strongest predictors of life satisfaction, a hierarchical multiple regression analysis was performed. Predictors were entered in four steps based on theoretical relevance: (1) 24hMB; (2) BMI; (3) weekly sport participation; (4) gender. Age, sitting time, sleep duration, total moderate-to-vigorous PA (MVPA) , and recreational MVPA were evaluated but excluded from the final model if they did not meet the inclusion criteria (p<0.05). Model fit was assessed using R^2, adjusted R^2, ΔR^2, and ANOVA change statistics; multicollinearity was evaluated using tolerance and VIF values. Statistical significance was set at p<0.05. All analyses were performed in IBM SPSS Statistics 29.0.

Results

The study included 2,611 university students from the V4 countries. Hungary contributed the largest proportion of participants (34.5%), followed by the Czech Republic (25.0%), Slovakia (22.5%), and Poland (18.0%). The sample was predominantly female (72.8%), with a mean age of 21.45 years (SD=2.22). In terms of nutritional status, most students fell within the normal BMI range (65.1%). Underweight (8.0%), overweight (18.0%), and obesity (7.4%) were also represented, with a mean BMI of 23.19 kg/m² (SD=4.24). Participants were enrolled across a diverse range of academic fields, most commonly Health and Sport Sciences (38.5%), followed by Humanities (16.9%) and Engineering (13.4%). Nearly two-fifths of the sample were first-year students (38.8%), with progressively smaller proportions in subsequent years of study. Life satisfaction was moderate overall, with a mean score of 6.71 (SD=1.62) on a 0 -10 ladder-type scale (Table 1).

Table 1. Sample characteristics

Characteristics	n	% / Mean (SD)
Country		
Czech Republic	652	25.0
Hungary	901	34.5
Poland	470	18.0
Slovakia	588	22.5
Gender		
Female	1901	72.8
Male	710	27.2
Age		
Age (years)	-	21.45 (2.22)
BMI		
Underweight (<18.5)	208	8.0
Normal (18.5-24.9)	1699	65.1
Overweight (25-29.9)	469	18.0
Obese (≥30)	194	7.4
BMI (kg/m^2)	-	23.19 (4.24)
Field of study		
Natural Sciences	163	6.2
Engineering	349	13.4
Medical Sciences	230	8.8
Humanities	440	16.9
Health and Sport Sciences	1005	38.5
Other	424	16.2
Grade at the university		
1st grade	1012	38.8
2nd grade	744	28.5
3rd grade	534	20.5
4th grade	211	8.1

5th grade	89	3.4
6th grade	21	0.8
Life satisfaction		
Life satisfaction	-	6.71 (1.62)

Most students reported engaging in sport or exercise for recreational purposes, with 59.9% participating in leisure-time sport without competitive goals. Organized but non-competitive sport was reported by 14.9%, while only 7.9% took part in competitive sport. Weekly sport frequency indicated that over half of the sample exercised 3-5 days per week (52.4%), with a mean of 3.74 days (SD=1.64).

Total MVPA averaged 2,632 minutes per week (SD=2,136.98), although this varied widely. Recreational MVPA alone accounted for 582 minutes per week on average (SD=634.99). When assessed against health benchmarks, 31.9% of students achieved ≥300 minutes/week of recreational MVPA (recommended for improving health), while 44.2% met the ≥150 minutes/week recommendation for maintaining health.

Sedentary behavior levels were notably high: 86.8% of students reported sitting for eight hours or more per day. Mean sitting time was 360.6 minutes on weekdays (SD=179.01) and 318.0 minutes on weekends (SD=188.47).

Sleep duration showed substantial variation. Fewer than half of the students (39.8%) achieved eight or more hours of sleep per night, while 43.2% reported sleeping less than eight hours. Average sleep duration was 7.65 hours (SD=0.95). When evaluated against 24hMB guidelines, only 26.9% of students met the recommended balance of activity, sedentary time, and sleep (Table 2).

Table 2. Sport participation, PA, sedentary behavior, and sleep

Variable	n	% / Mean (SD)
Type of sport		
Organized but not competitive	390	14.9
Recreational reasons in your leisure time	1563	59.9
Other	220	8.4
Competitive	207	7.9
Weekly sport (day/week)		
1-2 days	558	21.4
3-5 days	1367	52.4
6-7 days	397	15.2
Sports activity (days/week)	-	3.74 (1.64)
PA		
MVPA total (min/week)	-	2632.07 (2136.98)
Recreational MVPA (min/week)	-	582.47 (634.99)

Recreational MVPA - improve health		
≥300 min/week (meets)	834	31.9
<300 min/week (does not meet)	1772	67.9
Recreational MVPA - maintain health		
≥150 min/week (meets)	1153	44.2
<150 min/week (does not meet)	1453	55.6
Sitting time		
Sits ≥8h/day	2266	86.8
Sits <8h/day	289	11.1
Sitting time on weekdays (min/day)	-	360.64 (179.01)
Sitting time on weekends (min/day)	-	317.95 (188.47)
Daily sleep		
<8h/day	1129	43.2
≥8h/day	1040	39.8
Sleeping (hours/day)	7.65	0.95
24hMB		
Does not meet	1908	73.1
Meets the guidelines	703	26.9

Life satisfaction differed significantly across several demographic and health-related characteristics. Although women and men reported broadly similar levels, men showed a slightly higher mean score (6.82±1.59) than women (6.67±1.63), a difference that reached statistical significance (p=0.044).

Significant variation was also observed between countries. Polish students reported the lowest life satisfaction (6.53±1.72), while students from Hungary (6.79±1.61) and Slovakia (6.77±1.55) scored somewhat higher. Czech students reported 6.67±1.60. Overall, differences between countries were statistically significant (p=0.019).

A gradual pattern was observed across BMI categories**,** students with a normal BMI had the highest life satisfaction (6.82±1.56), followed by those who were underweight (6.69±1.57) and overweight (6.55±1.66), while those classified as obese reported markedly lower levels (6.22±1.80). The between-group comparison was significant (p<0.001).

The academic field showed no statistically significant association with life satisfaction (p=0.264). Still, small differences were visible: students in medical sciences reported slightly higher satisfaction (6.81±1.52), whereas those in humanities (6.63±1.75) and other fields (6.60±1.65) displayed somewhat lower means.

The most pronounced association was observed for self-rated health (SRH). Life satisfaction increased progressively with better perceived health, ranging from 4.46±2.87 among participants rating their health as poor, to 5.72±1.70 (fair), 6.37±1.44 (good), 7.30±1.37 (very good), and 8.17±1.36 among those reporting excellent health. This association was highly

significant (p<0.001), indicating a strong statistical association between subjective health and overall life satisfaction within this cross-sectional sample (Table 3).

Table 3. Life satisfaction across sociodemographic subgroups

Variable	Group	n	Mean (SD)	Test statistic
Gender	**Female**	1,901	6.67 (1.63)	Z=-2.01, p=0.044*
	Male	710	6.82 (1.59)	
Country	**Czech Republic**	652	6.67 (1.60)	H=9.96, df=3, p=0.019*
	Hungary	901	6.79 (1.61)	
	Poland	470	6.53 (1.72)	
	Slovakia	588	6.77 (1.55)	
BMI (kg/m²)	**Underweight**	208	6.69 (1.57)	H=24.83, df=3, p<0.001**
	Normal	1,699	6.82 (1.56)	
	Overweight	469	6.55 (1.66)	
	Obese	194	6.22 (1.80)	
Field of study	**Natural Sciences**	163	6.73 (1.58)	H=6.46, df=5, p=0.264
	Engineering	349	6.71 (1.56)	
	Medical Sciences	230	6.81 (1.52)	
	Humanities	440	6.63 (1.75)	
	Health and Sport Sciences	1,005	6.77 (1.59)	
	Other	424	6.60 (1.65)	

Notes: H – Kruskal-Wallis H, Z – Mann-Whitney U; * p<0.05, ** p<0.001.

Life satisfaction varied significantly by type of sport participation, with small to moderate differences observed between groups**.** Students involved in competitive sport reported the highest levels (7.15±1.45), followed by those engaged in organized non-competitive sport (6.84±1.55) and recreational activity (6.71±1.59). Those selecting "other" sport forms showed notably lower satisfaction (6.09±1.80). The overall between-group difference was statistically significant (p<0.001).

A dose-response-like pattern was observed for weekly sport frequency; students exercising 6-7 days per week reported the highest life satisfaction (7.16±1.47), compared with 6.69±1.57 among those active 3-5 days, and 6.38±1.74 among those exercising 1-2 days per week (p<0.001). This pattern suggests an association between more frequent sport participation and higher subjective well-being**,** without implying causality.

Recreational MVPA was also significantly associated with life satisfaction**,** although effect sizes remained modest. Those achieving ≥300 minutes/week scored significantly higher (6.99±1.56) than those below this threshold (6.58±1.63, p<0.001). A similar pattern was observed using the ≥150 minutes/week criterion for maintaining health: students who met the guidelines reported 6.92±1.57, compared with 6.54±1.64 among those that did not meet the guidelines (p<0.001).

Sedentary behavior showed a small inverse association with well-being. Students sitting more than 8 hours per day had significantly lower life satisfaction (6.44±1.75) than those sitting ≤8 hours (6.77±1.57, p<0.001).

Sleep duration demonstrated a small but statistically significant association with life satisfaction**.** Students sleeping ≥ 8 hours per night reported slightly higher life satisfaction (6.80±1.57) compared with those sleeping < 8 hours (6.67±1.61, p=0.043).

Finally, adherence to the integrated 24hMB guidelines was associated with higher life satisfaction**.** Those meeting the recommendation reported notably higher life satisfaction (7.05±1.52) than those who did not (6.59±1.64, p<0.001). This aligns with the growing evidence that balanced daily patterns, integrating PA, limited sedentary time, and adequate sleep, are associated with more favorable subjective well-being outcomes (Table 4).

Table 4. Life satisfaction in relation to sport participation, PA, sedentary behavior, and sleep

Variable	Group	n	Mean (SD)	Test statistic
Type of sport participation	**Organized**	390	6.84 (1.55)	H=45.80, df=3, p<0.001**
	Recreational	1,563	6.71 (1.59)	
	Other	220	6.09 (1.80)	
	Competitive	207	7.15 (1.45)	
Sport participation (days/week)	**1-2 days**	558	6.38 (1.74)	H=50.90, df=2, p<0.001**
	3-5 days	1,367	6.69 (1.57)	
	6-7 days	397	7.16 (1.47)	
Recreational MVPA	**≥300 min/week (meets)**	834	6.99 (1.56)	Z=-5.92, p<0.001**
	<300 min/week (does not meet)	1,772	6.58 (1.63)	
	≥150 min/week (meets)	1,153	6.92 (1.57)	Z=-6.02, p<0.001**
	<150 min/week (does not meet)	1,453	6.54 (1.64)	
Sedentary behavior	**≤8 h/day**	2,266	6.77 (1.57)	Z=-3.54, p<0.001**
	>8 h/day	289	6.44 (1.75)	
Sleep duration	**<8 h/night**	1,129	6.67 (1.61)	Z=-2.03, p=0.043*
	≥8 h/night	1,04	6.80 (1.57)	
24hMB	**Does not meet guidelines**	1,908	6.59 (1.64)	Z=-6.46, p<0.001**
	Meets guidelines			

Notes: H – Kruskal-Wallis H, Z – Mann-Whitney U, 24hMB – 24-hour movement behavior, MVPA – moderate-to-vigorous physical activity, * p<0.05, ** p<0.001.

The analysis examined how life satisfaction relates to a range of demographic factors (age, BMI) and behavioral variables reflecting PA patterns (total and recreational MVPA, sport frequency), sedentary time, and sleep duration. Life satisfaction showed no meaningful association with age (r=-0.001, p=0.948). BMI demonstrated a small but significant negative

correlation (r=-0.076, p<0.001), suggesting slightly lower satisfaction among students with higher body mass.

Movement-related behaviors showed small to modest but statistically significant associations. Total MVPA was weakly correlated with life satisfaction (r=0.057, p=0.004), whereas recreational MVPA showed a somewhat stronger relationship (r=0.102, p<0.001). Sport frequency also correlated positively (r=0.159, p<0.001), representing the most notable behavioral predictor. Sedentary behavior demonstrated a small negative association (r=-0.078, p<0.001), while sleep duration showed a weak positive correlation (r=0.052, p=0.016). Overall, the correlations ranged from very weak to moderate in magnitude.

The hierarchical regression (Table 5) provides a clear picture of how different predictors contribute to life satisfaction. The strongest single improvement occurs in Model 1, where the 24hMB alone explains 1.9% of the variance (R^2=0.019, p<0.001), demonstrating its meaningful standalone predictive value. Adding BMI in Model 2 yields a further 1.0% increase (ΔR^2=0.010, p<0.001), indicating that higher BMI is associated with lower life satisfaction. Including weekly sport participation in Model 3 contributes an additional 0.9% (ΔR^2=0.009, p<0.001), showing that sport engagement provides a unique positive effect. The final increment in Model 4, through adding gender, is modest but significant (ΔR^2=0.002, p=0.032), with women reporting slightly higher life satisfaction. Importantly, the largest gain occurs in Model 1, highlighting the primacy of the integrated 24h movement behavior relative to narrower behavioral components.

Table 5. Model summary for hierarchical regression predicting life satisfaction

Model (Predictors)	R	R^2	Adj. R^2	SE	ΔR^2	F Change	df1	df2	*p*
1 (24hMB)	0.139	0.019	0.019	1.570	0.019	41.453	1	2093	<0.001
2 (BMI)	0.170	0.029	0.028	1.563	0.010	20.617	1	2092	<0.001
3 (Sport days)	0.195	0.038	0.037	1.556	0.009	19.395	1	2091	<0.001
4 (Gender)	0.200	0.040	0.038	1.555	0.002	4.601	1	2090	0.032

The regression was already significant in Model 1 (F(1,2093)=41.453, p<0.001), confirming 24hMB as a key predictor. Each additional variable, BMI, sport days, and finally gender, led to further significant but small improvements, with Model 4 remaining robust (F(4,2090)=21.787, p<0.001). Overall, the ANOVA indicates that all added predictors contribute modestly to strengthening the model's explanatory power.

The final model highlights a clear pattern of meaningful predictors. The integrated 24hMB indicator was the strongest positive predictor of life satisfaction (β=0.100, p<0.001),

followed by weekly sport participation (β=0.098, p<0.001). BMI showed a significant negative association (β=-0.105, p<0.001), indicating lower satisfaction among students with higher body mass. Gender contributed only a small positive effect (β=0.047, p=0.032). Overall, these results confirm the dominant role of balanced 24-hour movement patterns and regular sport engagement, while BMI remained the strongest negative predictor (Table 6).

Table 6. Coefficients for final model (Model 4)

Predictor	B	SE	β	t	*p*
(Constant)	6.997	0.214	-	32.653	<0.001
24hMB	0.336	0.077	0.100	4.337	<0.001
BMI	-0.040	0.008	-0.105	-4.837	<0.001
Sport days	0.091	0.021	0.098	4.260	<0.001
Gender	0.165	0.077	0.047	2.145	0.032

Variables such as age, sitting time, total and recreational MVPA, and sleep did not enter the final model, underscoring that isolated behavioral components add no predictive value beyond the integrated 24hMB measure. Collinearity diagnostics further confirmed that all included predictors contributed unique information with no overlap, supporting the robustness of the final model.

Discussion

The present study examined a set of modifiable health-behavior factors in relation to university students' life satisfaction across four Central European countries. Although the overall explanatory power of the regression models was modest, this is consistent with previous research on subjective well-being, which is shaped by a wide range of psychological, social, cultural, and personality-related influences. Importantly, the results reveal stable and meaningful associations between specific behavioral indicators and life satisfaction, underscoring their relevance for health promotion among young adults.

Across successive models, better adherence to 24hMB guidelines consistently emerged as a positive correlate of life satisfaction, even after controlling for BMI, sport frequency, and gender. This suggests that balanced daily movement patterns, encompassing sufficient activity, limited sedentary time, and adequate sleep, may contribute to students' overall sense of well-being. Similarly, higher sport participation showed a small but consistent positive association, in line with previous findings that leisure-based, self-chosen activity confers greater psychological benefit than obligatory or work-related movement.

BMI showed a modest negative relationship with life satisfaction, in line with international studies linking higher BMI to lower perceived well-being among young adults, while gender differences were small, with female students reporting slightly higher life satisfaction after adjustment for covariates**.**

Taken together, these findings indicate that even within the complex, multifactorial domain of well-being, modifiable lifestyle behaviors retain significance. Public health and university-level interventions that encourage regular sport engagement and promote healthier 24-hour movement patterns may therefore support improvements in life satisfaction among students, despite the inherently limited variance such behavioral variables are expected to explain.

Life satisfaction is generally conceptualized as a cognitive appraisal of one's overall life circumstances and is regarded as a core component of subjective well-being [19]. Lower life satisfaction has been linked to both poorer mental and physical health outcomes [6,20-22], highlighting its relevance in emerging adulthood**.** In emerging adulthood, when many long-term educational, occupational, and relational trajectories are formed, understanding the determinants of life satisfaction is therefore of particular importance.

In our V4 university sample, mean life satisfaction was in the moderate range and showed relatively small yet systematic associations with movement behaviors and body weight status. The pattern we observed is broadly consistent with previous work indicating that physically active individuals tend to report higher life satisfaction, although effect sizes are typically modest [7]. In our multivariable model, an integrated 24hMB indicator emerged as the strongest positive behavioral predictor, even though it explained only a small proportion of the variance in life satisfaction. This aligns with the conceptual shift from examining isolated behaviors towards considering the combined balance of PA, sedentary time, and sleep within a 24-hour framework [18].

Weekly sport frequency was also a positive predictor of life satisfaction, corroborating studies showing that regular engagement in sport and leisure-time PA is linked to better subjective well-being [20,21]. However, the relatively small, standardized coefficient and low overall R^2 in our final model indicate that sport participation represents only one of many contributors to life satisfaction in this population. It is plausible that, for university students, academic demands, financial strain, social relationships, and perceived future prospects exert at least as much influence on life satisfaction as movement behaviors, which may dilute the explanatory power of PA indicators alone [23].

BMI showed a small but consistent negative association with life satisfaction in our analyses, in line with prior findings linking higher body weight to lower subjective well-being in adults [6]. This pattern may reflect internalized body ideals, weight-related stigma, or functional limitations associated with higher BMI. Taken together with the positive role of sport and 24hMB adherence, our results highlight that both "how one moves" and "how one feels in one's body" are relevant, albeit modest, correlates of life satisfaction in young adults. Interestingly, gender contributed only a small additional effect, with women reporting slightly higher life satisfaction than men, which is broadly compatible with larger European surveys that have found minor gender differences in favor of women [23].

Overall, our data reinforce three key points. First, life satisfaction among V4 university students appears relatively robust but far from optimal. Second, more favorable 24-hour movement patterns and regular sport participation are positively, though weakly, associated with higher life satisfaction, supporting the promotion of integrated movement-behavior approaches on campuses [18]. Third, the low explained variance underscores that life satisfaction in emerging adulthood is a multifactorial construct that cannot be meaningfully understood through movement behavior alone. Future research should therefore combine 24hMB indicators with richer psychosocial, academic, and economic measures to better capture the complex determinants of well-being in this critical life stage.

Recent evidence further refines the understanding of how physical activity relates to subjective well-being among university students. In a large Chinese study, Pan et al. [24] demonstrated that physical activity was not directly associated with subjective wellbeing; instead, its effects operated indirectly through psychosocial pathways. Specifically, higher levels of physical activity were linked to greater perceived social support and self-esteem, both of which showed significant positive associations with subjective well-being, whereas psychological resilience did not mediate this relationship. These findings highlight that the well-being benefits of physical activity in young adults may depend less on direct effects and more on its capacity to enhance social connectedness and self-evaluation, offering an important interpretative framework for understanding associations observed between movement behaviours and life satisfaction in university populations [24].

Sedentary behavior has also been identified as a key determinant of young adults' wellbeing. Pengpid et al. [25], using the SWLS and self-reported sitting time and screen-based sedentary behavior, showed that prolonged sitting and high recreational screen time were associated with lower life satisfaction, whereas PA buffered these negative effects. Although

sitting time did not remain an independent predictor in our adjusted model, its exclusion reinforces the superiority of the composite 24-hour movement indicator, which captures the synergy between activity, sedentary patterns, and sleep [25].

Recent international evidence consistently indicates that the association between PA and life satisfaction is not merely direct but is partly explained by underlying psychological mechanisms. In a large population-based study of Norwegian adolescents, Grasaas et al. [26] demonstrated that the relationship between PA level and life satisfaction was substantially mediated by self-efficacy. Among adolescents meeting the recommended levels of daily PA, more than half of the improvement in life satisfaction was explained through enhanced self-efficacy. This finding supports the present study's results, suggesting that integrated and sustained movement patterns are more strongly related to subjective well-being than isolated activity indicators [26].

Comparable mediation pathways were identified among Chinese university students by Deng et al. [27], who reported that the positive association between PA and life satisfaction was partially mediated by both self-efficacy and resilience. Although the cultural context differs from Central Europe, these findings reinforce the notion that PA contributes to life satisfaction through the development of psychological resources, lending further support to the holistic 24hMB framework applied in the present study [27].

The role of attitudes towards PA was examined by Ayhan et al. [28] in a sample of Turkish university students. Their results showed that positive outcome expectations and self-regulation related to PA were significantly associated with higher life satisfaction, although the explained variance remained modest. This pattern closely mirrors the present findings, where behavioral predictors accounted for a limited but meaningful proportion of variance in life satisfaction [28].

Finally, Potoczny et al. [29] showed in a European adult sample that the association between regular PA and life satisfaction was fully mediated by dispositional self-control and cognitive reappraisal. Although not restricted to university students, these findings conceptually align with the present study, reinforcing the interpretation of PA as a behavioral pattern embedded within broader self-regulatory and psychological processes rather than as an isolated health behavior [29].

Taken together, the present findings and the wider body of evidence indicate that movement behaviors, while explaining only a modest proportion of variance, remain consistent correlates of life satisfaction in emerging adulthood. Balanced whole-day movement patterns

and regular sport participation are positively associated with subjective well-being across diverse cultural contexts, even when their individual effects are small. This modest explanatory power reflects the inherently multifactorial nature of life satisfaction rather than limited behavioral relevance. The observed negative association with BMI further highlights the close interplay between physical and psychological well-being during this transitional life stage. Importantly, movement-related behaviors represent accessible and modifiable targets for university health promotion; supporting students in developing healthier 24-hour routines that integrate PA, reduced sedentary time, and adequate sleep may therefore contribute to incremental yet meaningful improvements in life satisfaction.

Limitations

Several limitations should be considered when interpreting these findings. First, the cross-sectional design precludes causal inference; although movement behaviors were associated with life satisfaction, temporal directionality cannot be established. Longitudinal or experimental designs are required to determine whether improvements in 24-hour movement patterns lead to subsequent gains in subjective well-being. Although validated self-report instruments were used (IPAQ-LF, sport frequency, sleep duration, and sitting time), their reliance on recall introduces the risk of measurement bias. Importantly, device-based ActiGraph measurements were collected in each participating country on a subsample of approximately 50 students; however, these objective data were not included in the present analyses. Future studies should explicitly incorporate such device-based measures (e.g. actigraphy or accelerometry) to provide more precise estimates of movement behaviors and to further clarify their association with life satisfaction.

The current analytical sample consisted exclusively of university students. While this offers important insights into emerging adulthood, it limits generalizability to non-student youth or those outside tertiary education. Notably, a large additional dataset was collected in parallel among secondary school students across diverse school types in all participating countries. Future work comparing adolescents and university students would be valuable for understanding age-related trajectories and contextual differences in life satisfaction and movement behaviors. The regression models included BMI, gender, and sport participation, and they explained only a small proportion of variance in life satisfaction. This underscores that subjective well-being is inherently multifactorial and that unmeasured psychosocial variables,

such as perceived stress, academic demands, social connectedness, or financial pressure, likely play substantial roles in shaping life satisfaction during this life stage.

Conclusions

This study demonstrates that, within a large sample of university students from V4 countries, more favorable 24hMB profiles and regular sport participation are modest yet consistent positive correlates of life satisfaction. These findings support an integrative perspective on movement behaviors, highlighting that the balance between PA, sedentary time, and sleep may be more informative for subjective well-being than any single behavior alone. Although the overall explanatory power of the models was small, the behavioral determinants identified are modifiable and therefore suitable targets for health promotion in higher-education settings. Interventions encouraging regular engagement in sport, reducing prolonged sitting, and promoting healthier sleep-wake routines may contribute to incremental improvements in students' life satisfaction. Future research should build on these findings using longitudinal designs and richer psychosocial datasets to gain a deeper understanding of the complex determinants of well-being during emerging adulthood.

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