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ORIGINAL ARTICLE

The relationship between physical activity, postural awareness, low-back pain, and quality of life in university students: The role of gender and body weight

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Abstract

This study aimed to determine differences in postural awareness (PAS), low-back pain severity, and quality of life (QoL) across physical activity (PA) levels, gender, and weight parameters among university students. This cross-sectional study included 93 undergraduate students aged 18 to 25 years. Participants were categorised into inactive, minimally active, and active groups based on their PA scores obtained from the International Physical Activity Questionnaire. PAS was assessed using the Postural Awareness Scale, low-back pain was measured using a Visual Analog Scale (VAS), and QoL was evaluated using the WHOQOL-BREF. Intergroup comparisons were performed using ANOVA, and adjusted analyses for the weight variable, which initially differed between groups, were performed using ANCOVA. Multiple linear regression analyses evaluated the effect of the PA group and gender. Gender distribution (p=0.015) and weight (p=0.016) differed between groups. In unadjusted analyses, rest and night pain showed significant differences according to PAS groups (p<0.01); the inactive group had higher night pain and lower PAS. The active group had a higher psychological and social subparameters of

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WHOQOL-BREF ($p<0.05$). After weight adjustment, differences in rest pain ($p=0.033$), night pain ($p=0.001$), and PAS ($p=0.009$) persisted, while differences in QoL domains lost their significance. In regression, PA level was negatively associated with rest/night pain and positively associated with PAS and psychological-social quality of life ($p<0.05$). Higher PA levels in university students are associated with better postural awareness and lower back pain (especially night pain). Approaches to increase PA might be beneficial in PAS and pain management.

Introduction

Contemporary university students face a growing prevalence of sedentary behavior, driven by a combination of academic pressures, social obligations, and the pervasive use of digital technology [1]. Sedentary lifestyles lead to decreased levels of physical activity (PA), which is associated with various health problems, especially musculoskeletal (MSK) disorders and weight gain. One common consequence of this decline is neck, back, and low back pain, which can negatively affect students' daily lives and academic performance [2-4]. It is therefore of significant importance to address the risks associated with a sedentary lifestyle and the resulting health complications.

Postural disorders are a significant cause of pain, particularly in sedentary individuals who spend extended periods in an office environment, frequently use computers and mobile devices, and work in non-ergonomic settings [5, 6]. Postural awareness (PAS), defined as the individual's ability to perceive body position and movement, has been identified as a critical factor in maintaining MSK health [7]. Regular physical exercise has been shown to promote PAS by enhancing postural control and muscle strength; yet, insufficient PA increases the risk of postural problems and pain conditions [8].

Quality of life (QoL), encompassing individuals' physical and psychological health, social connections, and environment, is a primary factor influencing how physically active university students are. Studies have shown that regular PA is positively correlated with QoL and is also associated with lower levels of pain severity and postural problems [9,10]. Although the connections between PA and pain perception and QoL have been explored in various groups, the precise way this relationship works with PAS in university students is not yet obvious.

Although the concepts of posture, low-back pain, and QoL have been studied in health sciences for a long time [10], the concept of "PAS" is a relatively new approach and has not been sufficiently investigated, especially in young adults such as university students. While the physiological effects of postural disorders and their contribution to pain have been examined in the extant literature, studies on the level of PAS are limited [11,12]. As being well documented in the literature, a sedentary lifestyle has been shown to have a detrimental effect on the MSK system and associated pain problems. However, the role of PA, gender, and weight in these dynamics and their relationship with PAS, low-back pain, and QoL is not yet fully understood. In this regard, comparing these parameters among university students classified as active, minimally active, and inactive will help close the knowledge gap on the subject.

The aim was to determine differences in PAS, low-back pain severity, and QoL according to PA levels, gender, and weight parameters among university students.

Materials and Methods

Ethical aspects of research

Following approval from Erzurum Technical University Ethics Committee (Meeting No: 08, Decision No: 10, Date: 22.05.25). The study was performed in accordance with the Declaration of Helsinki.

Type of the study

This research was planned as a cross-sectional study.

Sampling and eligibility criteria

A total of 93 participants, all of whom were undergraduate students from the Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, aged between 18 and 25 years, were enrolled in the study. Participants' PA level was determined by using the International Physical Activity Questionnaire (IPAQ) [13]. Participants were allocated to inactive (<600 MET-min/week), minimally active (600-3000 MET-min/week), and active (>3000 MET-min/week) PA groups based on weekly metabolic equivalent of task (MET-min/week) scores.

To be included in the study, participants had to be able to walk at least 150 meters, have no orthopedic or neurological conditions, and be proficient in Turkish to understand the instructions. Students who did not meet these criteria or declined to participate during the data collection phase were excluded.

Setting/Location

The University therapeutic exercise laboratory was used to perform the study.

Power analysis

A power analysis was conducted to ascertain the minimum required sample size prior to the commencement of the study. G*Power 3.1.9.4 software was utilized to perform this analysis. In the calculation based on the study by Maden et al. [14], the minimum number of participants was determined to be 87 for an effect size of 0.37, a confidence interval of 95%, and a margin of error of 0.05. Given the potential for missing data and the possibility of participants withdrawing from the study prior to its conclusion, 93 individuals were enrolled.

Assessments and measurement tools

After the participants were separated into three PA groups based on the IPAQ scores, each group received questionnaires on PAS, low-back pain, and QoL. Demographic data, including gender, age, height, weight, and Body Mass Index (BMI), were collected. The same researcher performed the measurements in a quiet environment, and each session lasted approximately 30 minutes.

Physical Activity Level: IPAQ, a validated tool in Turkish [13], was utilized to measure PA levels. This survey includes questions about the frequency and duration of walking, as well as moderate and vigorous activities over the past week. Each activity is assigned with a MET value (walking=3.3, moderate=4, vigorous=8), and these are used to calculate a total score in MET-minutes per week.

Pain Assessment: A previous study has shown that low-back pain is a crucial indicator of low-level general health and can be used as an assessment tool for this purpose [15]. In this study, the level of low-back pain was assessed using a visual analog scale (VAS) in three situations (rest, movement, night). VAS, a valid and reliable method for pain assessment, was used [16]. This scale is a standardized assessment tool that allows participants to mark their subjective pain experience on a 10-centimeter (cm) horizontal line from "no pain" (0 cm) to "excruciating pain" (10 cm). During the measurements, the points marked by the participants are measured with a millimeter ruler and converted to numerical values between 0 and 10. In the study, three different VAS measurements specific to rest, movement, and night periods were performed to evaluate the pain experiences of university students in various physiological states.

Postural Awareness (PAS): The valid and reliable Postural Awareness Scale (PAS) was used to assess postural awareness. The PAS is a standardised, self-report measure that assesses the extent to which an individual is aware of their body posture in daily life and whether this awareness occurs easily/automatically or requires attention and effort. The scale measures individuals' subjective awareness of their body posture in static and dynamic positions and consists of two subscales: (1) ease/familiarity with postural awareness, (2) need for attention regulation for postural awareness. The Turkish adaptation of the scale contains 11 items, each scored on a 1–7 Likert-type scale (1 = 'not at all applicable to me', 7 = 'completely applicable to me'). After reverse items are corrected as needed, the total score is calculated on a scale of 11–77; higher scores indicate greater postural awareness. The subscale score ranges are 6–42 and 5–35, respectively [17].

Quality of Life (QoL): The World Health Organization (WHO) Quality of Life-BREF (WHOQOL-BREF) scale, validated for use with the Turkish population [18], was employed to evaluate the QoL among university students. This reliable and valid 26-item instrument assesses individuals' subjective perceptions of their QoL over the preceding two weeks. Responses are captured on a 5-point Likert scale, and the tool is designed to measure the domains of physical health, psychological status, social relationships, and environmental factors [19].

Statistical analysis

The statistical analysis of the data was performed using the IBM SPSS Statistics programme (version 24.0; IBM Corp., Armonk, NY, USA). Continuous variables were reported as mean ± standard deviation (SD), categorical variables as number (n) and percentage (%). Gender distribution between groups was compared using the chi-square (χ^2) test. One-way analysis of variance (ANOVA) was used to compare age, height, weight, and Body Mass Index (BMI) values between PA groups. The raw (unadjusted) differences between PA groups in terms of primary outcome variables—pain intensity (VAS: rest, movement, and night), postural awareness (PAS total score), and quality of life (WHOQOL-BREF domain scores)—were assessed using one-way ANOVA. Where the omnibus test was significant, pairwise comparisons were performed using the Tukey post-hoc test. Due to significant differences in gender distribution and weight between groups at baseline, the outcome variables were additionally assessed using a covariance analysis (ANCOVA), with weight included as a covariate. Homogeneity of regression slopes was evaluated by testing the PA Group×Weight interaction; no significant interactions were observed ($p>0.05$). Effect size was reported using partial eta-squared (ηp^2). For variables with a significant main effect in ANCOVA, pairwise comparisons were performed using Bonferroni correction for multiple comparisons. Finally, multiple linear regression analyses were performed to examine the impact of the PA group and gender (independent variables) on pain, PAS, and QoL. Regression results were presented with the correlation coefficient (R), explained variance (R^2), standardised coefficient (β) for the physical activity group, t-value, and p-value. The level of statistical significance was accepted as $p<0.05$ in both directions.

Results

A total of 93 participants aged 18–25 were included in the study. Gender distribution differed significantly according to PA groups (χ^2, $p=0.015$); the proportion of males was higher in the active group (Table 1).

Table 1. Comparison of gender distribution of participants according to groups.

Gender	Inactive; n (%)	Minimally Active; n (%)	Active; n (%)	Total; n (%)	*p* value
Female	15 (88.2)	35 (85.4)	21 (60.0)	71 (76.3)	**0.015**
Male	2 (11.8)	6 (14.6)	14 (40.0)	22 (23.7)	

The comparison of the gender distribution between groups was performed with the chi-square (χ2) analysis method. n: number of participants, %: percentage

Age, height, and BMI values were similar across groups (all *p*>0.05). However, weight values showed a significant difference between groups (F = 4.310, *p*=0.016), and the active group had a higher average weight (Table 2).

Table 2. Comparison of age, height, weight, and body mass ındex (BMI) values of the participants by groups.

Variable	Group	N	Mean ± SD (Year/cm/kg)	F	*p*
Age	Inactive	17	21.12±1.73	2.033	0.137
	Minimally Active	41	21.51±1.65		
	Active	35	20.77±1.48		
Height (cm)	Inactive	17	162.82±9.38	0.766	0.468
	Minimally Active	41	164.68±6.99		
	Active	35	167.11±17.53		
Weight (kg)	Inactive	17	59.53±10.34	4.310	**0.016**
	Minimally Active	41	63.05±10.70		
	Active	35	73.03±25.95		
BMI (kg/m^2)	Inactive	17	22.37±2.97	1.644	0.199
	Minimally Active	41	23.34±4.00		
	Active	35	25.84±11.07		

A one-way ANOVA was used to compare group differences. BMI: Body Mass Index, SD: Standard deviation, cm: centimeter, kg: kilogram, m: meter

There was a significant difference between PA groups in terms of rest pain (F=5.051; *p*=0.008) and night pain (F=9.168; *p*<0.001) (Table 3). According to Tukey test, the active group reported lower pain at rest than the minimally active (*p*=0.029) and inactive (*p*=0.020) groups; night pain was higher in the inactive group than in the minimally active (*p*=0.022) and active groups (*p*<0.001). Although the omnibus ANOVA was significant for movement pain (F=3.488; *p*=0.035), there were no significant differences in pairwise comparisons (Table 3).

Table 3. Comparison of pain levels according to physical activity groups.

Variable	Groups	N	Mean ± Sd	F	Anova Sig. (*P*)	*P**	*P#*	*P$*
Pain (Rest)	Inactive	17	2.71±2.05	5.051	**0.008**	0.742	**0.029**	**0.020**
	Minimally Active	41	2.34±1.17					
	Active	35	1.31±2.04					
Pain (Movement)	Inactive	17	3.88±2.76	3.488	**0.035**	0.912	0.064	0.082
	Minimally Active	41	3.61±2.05					

	Active	35	2.40±2.37					
Pain (Night)	Inactve	17	4.06±1.56	9.168	**<0.001**	**0.022**	0.098	**<0.001**
	Minimally Active	41	2.54±1.86					
	Active	35	1.60±2.20					

P: Between group comparison with one-way ANOVA test, P: Comparison of inactive and minimal active groups with post-hoc Tukey test, P#: Comparison of minimal active and active groups with post-hoc Tukey test, P$: Comparison of inactive and active groups with post-hoc Tukey test, PAS: Postural Awareness Scale*

There was a significant difference in PAS scores between PA groups (F=5.947; *p*=0.004); according to Tukey, the inactive group had lower PAS scores than the minimally active group (*p*=0.021) and the active group (*p*=0.003). QoL was significantly different between groups in the psychological domain (F=3.363; *p*=0.039) and the social relationships domain (F=3.527; *p*=0.034); the active group scored higher than the inactive group (psychological: *p*=0.035; social: *p*=0.026). There were no significant differences between the groups in the physical health (*p*=0.099) and environment (*p*=0.691) domains (Table 4).

Table 4: Comparison of postural awareness and quality of life levels according to physical activity groups.

Variable	Groups	N	Mean ± SD	F	P value	P*	P#	P$
PAS	Inactive	17	36.05±10.50	5.947	**0.004**	**0.021**	0.595	**0.003**
	Minimally Active	41	44.65±11.06					
	Active	35	47.11±11.05					
Physical Health	Inactive	17	52.87±14.66	2.368	0.099	0.091	0.937	0.173
	Minimally Active	41	61.92±16.32					
	Active	35	60.76±12.75					
Psychological	Inactive	17	49.27±13.52	3.363	**0.039**	0.386	0.256	**0.035**
	Minimally Active	41	54.87±14.58					
	Active	35	60.24±15.33					
Social Relations	Inactive	17	51.23±17.15	3.527	**0.034**	0.115	0.661	**0.026**
	Minimally Active	41	60.87±15.78					
	Active	35	64.19±17.25					
Environment	Inactive	17	57.09±14.12	0.372	0.691	0.683	0.865	0.910
	Minimally Active	41	60.45±13.86					
	Active	35	58.80±14.14					

P: Between group comparison with one-way ANOVA test, P: Comparison of inactive and minimal active groups with post-hoc Tukey test, P#: Comparison of minimal active and active groups with post-hoc Tukey test, P$: Comparison of inactive and active groups with post-hoc Tukey test, PAS: Postural Awareness Scale*

In the analysis adjusted for weight covariates, significant differences persisted between PA groups in terms of resting pain (F=3.56; *p*=0.033; ηp^2=0.074) and night pain (F=7.09; *p*=0.001; ηp^2=0.137). In contrast, movement pain was not significant (F=2.53; *p*=0.086) (Table 5). The PAS total score also showed a significant difference between groups after weight adjustment (F=5.02; *p*=0.009; ηp^2=0.101). In terms of QoL (WHOQOL-BREF), weight-adjusted group differences were not significant in the psychological (*p*=0.116) and social (*p*=0.100) domains (Table 5).

Table 5. Comparison of pain, postural awareness, and quality of life by physical activity groups (adjusted for weight)

Variables	Inactive (n=17) M ± SD	Minimally Active (n=41) M ± SD	Active (n=35) M ± SD	F	*p*	ηp²
Pain (Resting)	2.71 ± 2.05	2.34 ±1.17	1.31 ± 2.04	3.56	0.033*	0.074
Pain (Night)	4.06 ± 1.56	2.54 ± 1.86	1.60 ± 2.20	7.09	0.001**	0.137
Pain (Movement)	3.88 ± 2.76	3.61± 2.0 5	2.40 ± 2.37	2.53	0.086	0.054
PAS	36.06 ± 10.50	44.66 ± 11.07	47.11 ± 11.05	5.02	0.009**	0.101
Psychological	49.27 ± 13.52	54.87 ± 14.58	60.24 ± 15.33	2.21	0.116	0.047
Social	51.23 ± 17.15	60.87 ± 15.78	64.19± 17.25	2.36	0.100	0.050

*M: Mean, SD: Standard Deviation, PAS: Postural Awareness Scale, QoL: Quality of Life (WHOQOL-BREF). Values are adjusted for the covariate: Weight . *p < .05, **p < .01, ηp²:eta square*

In Bonferroni-adjusted pairwise comparisons, the inactive group had significantly higher night pain scores than the minimally active group (mean difference = 1.462; *p*=0.032) and the active group (mean difference = 2.229; *p*=0.001). In terms of PAS total score, the inactive group was found to be significantly lower than the minimally active group (mean difference = −8.417; *p*=0.029) and the active group (mean difference = −10.354; *p*=0.008). Pairwise comparisons for rest and movement pain were not significant after Bonferroni correction (Table 6).

Table 6. Post-hoc pairwise comparisons for pain and postural awareness.

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	*p*	95% CI [LB; UB]
Pain (Resting)	Inactive	Minimally Active	0.319	0.494	1.000	[-0.886, 1.524]
		Active	1.219	0.523	0.066	[-0.056, 2.494]
Pain (Movement)	Inactive	Minimally Active	0.228	0.668	1.000	[-1.403, 1.859]
		Active	1.312	0.707	0.201	[-0.414, 3.037]
Pain (Night)	Inactive	Minimally Active	1.462*	0.559	**0.032**	[0.097, 2.827]
		Active	2.229*	0.592	**0.001**	[0.784, 3.673]
PAS (Total)	Inactive	Minimally Active	-8.417*	3.176	**0.029**	[-16.168,-0.666]
		Active	-10.354*	3.361	**0.008**	[-18.555,-2.153]

Adjustment for multiple comparisons: Bonferroni. The mean difference is significant at the .05 level. I and J symbolize references and comparison groups. LB:Lower Bound UB:Upper Bound.

In multiple linear regression analyses adjusted for gender, the PA group was found to be negatively associated with rest pain (β = −0.218; *p*=0.036) and night pain (β = −0.339; *p*=0.001). The relationship between movement pain and the outcome was not significant (*p*=0.068). The PA group was also positively associated with PAS (β=0.283; *p*=0.006) and showed positive associations with the psychological (β=0.214; *p*=0.041) and social domains (β=0.243; *p*=0.024) of QoL. The explanatory power of the model is low to moderate based on R^2 values (R^2 = 0.038–0.116) (Table 7).

Table 7. Linear regression analysis of physical activity and gender on pain, posture, and quality of life.

Dependent Variables	R	R2	β	t	*p*-value
Pain (Resting)	0.221	0.049	-0.218	-2.126	**0.036***
Pain (Movement)	0.194	0.038	-0.190	-1.849	0.068
Pain (Night)	0.340	0.116	-0.339	-3.425	**0.001***
PAS	0.284	0.081	0.283	2.812	**0.006***
Psychological	0.214	0.046	0.214	2.073	**0.041***
Social	0.254	0.065	0.243	2.295	**0.024***

*PAS: Postural Awareness Scale, QoL: Quality of Life. Predictors: (Constant), Gender, Physical Activity Group. Beta (β) represents the standardized coefficient for the Physical Activity Group. *p < 0.05, **p < 0.01. PA*Gender*

Discussion

This study comprehensively examined the associations between PA level and QoL, PAS, and low-back pain severity in university students, while accounting for baseline differences in gender distribution and weight, and found significant group differences in PAS scores, low-back pain scores, and the psychological and social relationships domains of QoL. The results indicated significant group differences in resting pain, night pain, and PAS, while differences in the psychological and social relationships domains of QoL became non-significant after weight adjustment.

The relationship between pain and PA levels is a multifaceted issue that various studies have investigated. In a study involving Norwegian University students, more frequent, intense, and more extended periods of physical activity were linked to a reduced risk of chronic pain [3]. A study of college students performed during the COVID-19 pandemic shows clear evidence that decreased PA is related to sleep quality, MSK pain, and the frequency of days with migraines [20]. In another pandemic period study, it was emphasized that low physical activity levels were associated with the onset of MSK pain and its exacerbation [21]. The outcomes of our study revealed a significant relationship between PA levels and pain perception, specifically for resting and night pain, which remained significant after adjusting for weight. This aligns with the literature.

An examination of the literature regarding physiological mechanisms reveals that regular PA increases endorphin release, producing a natural analgesic effect. Endorphins reduce pain perception by inhibiting pain transmission within the central nervous system. Furthermore, exercise may attenuate the inflammation underlying chronic pain by lowering inflammatory markers [22]. Conversely, sedentary individuals often exhibit decreased muscle strength, restricted range of motion, and poor postural control, all of which contribute to increased pain sensitivity [21]. In particular, prolonged sitting and non-ergonomic working conditions significantly predispose to the development of pain in various regions, particularly the neck, back, and lower back. It is thought that stronger muscles and better PAS in active individuals may reduce the risk of pain by reducing stress in these areas. Given that these physiological mechanisms suggest exercise improves pain relief, it could be speculated that the significant differences observed between groups in our study stem primarily from variations in PA levels. This can also be observed when examining the results obtained from PA*Weight and PA*Gender analyses.

The existing literature contains a limited number of studies exploring the relationship between PA and PAS. Evidence suggests that inadequate PAS is associated with a higher prevalence of MSK disorders, particularly among specific populations such as dental students [23]. This finding underscores the importance of enhanced education regarding proper posture. In another study, it was shown that PA in a clinical pilates class increased PAS and flexibility in physiotherapy students and corrected posture disorders [12]. In our study, the PAS scores showed a statistically significant difference among PA groups even after weight adjustment. This finding supports the literature cited above, which indicates that physical activity can increase PAS by improving postural control and muscle strength. More active people may have better postural control and body awareness, making "good" posture a more conscious and instinctive process. Individuals with sedentary lifestyles exhibited lower PAS scores, likely due to postural disorders and predisposition to pain.

PA and influence on QoL is a multifaceted topic that encompasses a variety of health conditions and interventions. When assessing QoL, it is appropriate to evaluate multiple parameters separately. Because the measure we employed in our study was specifically constructed for this purpose, we were able to conduct a thorough examination of university students' QoL.

A substantial body of the study has explored the relationship between PA levels and the QoL among university students. It is widely recognized that regular and targeted PA contributes to improvements in students' overall QoL [24]. Furthermore, it has been demonstrated that even modest increases in PA can lead to favorable mental health outcomes [25]. Moderate to vigorous physical activity has been indicated to be positively associated with improved QoL among university students [26]. These benefits contribute to a higher QoL, as students who are physically active report better mental health scores [27]. Our study also yielded similar and supportive results to these data. However, the data obtained after body weight adjustment may indicate that quality of life can be affected beyond solely PA. If this condition was detailed, initial analysis (ANOVA results) showed significant differences were found between the PA groups in the sub-dimensions of psychological health and social relationships in the QoL assessment. However, after weight adjustment (ANCOVA), these differences in QoL domains lost their statistical significance. This suggests that weight may play a mediating role in the relationship between PA and QoL in this population.

No significant differences were observed among the groups in the sub-dimensions of physical health and environmental QoL. The lack of a substantial difference in physical health may be attributed to the study's predominantly female sample. This is consistent with findings in the literature indicating that male students tend to exhibit higher levels of PA and better QoL scores than their female counterparts [26]. The absence of a significant difference in the environmental QoL sub-dimension suggests that students' environmental conditions, such as living space, safety, and transportation, may be uniform across all PA groups. These factors are often influenced by the general conditions of the university or city rather than individual preferences.

ANCOVA analysis showed that PA, even when controlling for weight, was significantly associated with lower pain levels and higher PAS scores. This aligns with) the established role of PAS in MSK health, where an increase in PA results in an enhancement of PAS through the improvement of postural control and muscle strength. While the direct impact of PA on QoL domains was less pronounced after adjustments, the strong associations with pain reduction and postural awareness remain critical findings for this student population. However, it is essential to note that insufficient of QoL values after weight adjustment has been demonstrated to precipitate discomfort with overweight [28]. Moreover, the absence of a substantial direct impact of PA on QoL in this university student population, even after weight adjustment, suggests the possibility of more complex mediating or modulatory factors influencing this relationship. It is acknowledged that this relationship may be more pronounced in individuals with chronic pain [7]; therefore, it is understandable that a direct relationship could not be detected in a general student population.

Furthermore, the results of the multiple linear regression analyses provide significant insight into the independent predictors of the study's outcomes. When gender was included in the model alongside physical activity levels, it did not emerge as a statistically significant predictor for PAS, low-back pain severity, or the various domains of QoL compared to initial analysis. This finding might be suggests that the benefits of physical activity are universal within this student population and are not dependent on an individual's gender. It can be inferred that the physiological and psychological improvements associated with higher activity levels—such as enhanced postural control and reduced pain—function independently of gender-based biological differences. Consequently, this might indicates that physical activity might be a primary and direct factor in better MSK health and well-being. Such a result is encouraging for health promotion within universities, as it implies that interventions designed to increase activity levels can be expected to be equally effective for all students, regardless of the gender distribution of the group.

As a limitation of this study, weight and gender differed significantly between the groups. Homogeneity between the groups was not achieved due to the increasing proportion of female participants. The low number of men in the inactive group limited the ability to test PA×Gender interactions and reduced power; even after statistical adjustment, sample imbalance may still have created uncertainty. Unequal group sizes and gender distribution may have reduced statistical power and increased the risk of Type II error.

Conclusion

This study comprehensively reveals the determining role of PA level on PAS, low back pain severity, and QoL in university students. The findings confirm that an active lifestyle has a direct and positive impact not only on general health but also on postural awareness and pain management, which are critical components of musculoskeletal health. One of the most striking results of the study is that an increase in PA level reduces resting and nocturnal pain and significantly increases PAS scores, independently of potential confounding variables such as body weight. Multiple linear regression analyses show that gender does not have a statistically significant effect on these parameters and that the benefits of physical activity are universal for both male and female students. This might demonstrate that physical activity interventions within the university will provide similar physiological gains in the entire student population regardless of gender. On the other hand, the fact that the relationship between PA and the psychological and social dimensions of QoL loses significance when body weight is included in the model suggests that body composition may mediate this relationship in this population. In conclusion, reducing sedentary behavior and promoting regular exercise among university students should be adopted as a fundamental strategy to prevent postural disorders and manage low back pain. Future studies should examine the long-term protective effects of postural awareness on musculoskeletal health using larger, more homogeneous samples.

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Conflict of interest

The authors declare no conflict of interest.

Data availability statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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