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Relationship of Sedentary Behaviour and Physical Activity Levels with Functional Mobility in University Students

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ABSTRACT

Background: Sedentary behaviour and physical inactivity are increasingly common in university students and may influence functional mobility despite young age and preserved health. Objective: To investigate the relationship between sedentary behaviour, physical activity levels, and functional mobility in university students. Methods: A cross-sectional study was conducted among 267 students aged 18–25 years. Sedentary behaviour was assessed using the Sedentary Behaviour Questionnaire, physical activity using the International Physical Activity Questionnaire, and functional mobility using the Timed Up and Go test and the 10-Meter Walk Test. Sedentary time was categorized into quartiles, and walking speed was categorized into normal versus fast. Associations were examined using Pearson's Chi-square test with effect size estimation. Results: Participants reported a mean sedentary time of 6.14±2.43 hours/day and were predominantly moderately active (99.6%). Mean TUG was 9.52±0.81 seconds and mean gait speed was 1.33±0.12 m/s. Walking-speed category differed significantly across sedentary quartiles (χ^2=11.49, df=3, p=0.009; Cramér's V=0.207), with normal walking speed increasing from 8.8% in Q1 to 26.9% in Q4. Compared with Q1, Q4 showed higher odds of normal walking speed (OR=3.82; 95% CI 1.40–10.45). Conclusion: Higher sedentary behaviour was significantly associated with slower gait performance despite moderate physical activity, highlighting the need to reduce prolonged sitting in university populations.

Keywords
Sedentary behaviour, Physical activity levels, Functional mobility, IPAQ, SBQ, Timed Up and Go Test, 10-Meter Walk Test.

INTRODUCTION

Sedentary behaviour and insufficient physical activity have emerged as major modifiable lifestyle risks among young adults, particularly in university settings where academic workload, screen-based learning, and prolonged sitting dominate daily routines. Global recommendations for adults aged 18–64 advise engaging in at least 150 minutes of moderate-intensity physical activity or 75 minutes of vigorous-intensity physical activity weekly, while also emphasizing the need to minimize sedentary time, yet a substantial proportion of adults and adolescents fail to meet these targets, indicating a persistent and widening movement-health gap among youth transitioning into adulthood (1). Sedentary behaviour is now understood as a distinct behavioural construct characterized by waking time sitting or reclining at ≤1.5 metabolic equivalents, and its adverse physiological effects may persist even in individuals who meet physical activity guidelines (2). Evidence from accelerometer-based meta-analyses indicates dose–response relationships between sedentary exposure, low movement volume, and adverse health outcomes, supporting the concept that prolonged sitting contributes independently to morbidity and functional decline (3). Among university students, sedentary time is commonly accumulated through lectures, studying, commuting, and recreation, with cross-national studies reporting consistently high daily sitting duration and notable demographic variability by sex, academic year, and body mass index (4).

Functional mobility represents a critical dimension of physical health, encompassing the ability to rise from sitting, ambulate efficiently, turn, and transfer safely during routine activities of daily living. Although overt functional limitations are typically associated with older age, early subtle deterioration in gait mechanics, dynamic balance, and movement efficiency may begin in young adulthood and serve as a precursor to later disability, musculoskeletal pain, and reduced quality of life (5). Standardized functional assessments such as 10MWT and the Timed Up and Go (TUG) test provide clinically interpretable, performance-based indices of mobility and have demonstrated utility in detecting early mobility changes and fall-risk trajectories across populations (6,7). University students frequently report musculoskeletal discomfort and postural dysfunction linked to prolonged screen time and suboptimal ergonomic environments, conditions that may impair trunk endurance, postural control, and gait efficiency even before clinically obvious limitations occur (8). Prolonged sitting has also been associated with reduced muscle activation, altered spinal curvature, and impaired neuromotor coordination, all of which may influence walking performance and movement economy (9).

While physical activity confers well-established cardiometabolic and musculoskeletal benefits, the relationship between physical activity level and functional mobility in young adults remains complex and partly inconsistent, particularly when physical activity is assessed by self-report and when sedentary exposure is simultaneously high (10). Systematic syntheses indicate that physical activity and sedentary behaviour should not be considered as opposite ends of a single continuum; rather, they operate as partially independent behaviours with distinct physiological pathways and health consequences (11). Cross-sectional and longitudinal evidence in young adults suggests that high sedentary time is associated with poorer

fitness, fatigue, and compromised well-being, even among individuals who value exercise and report moderate activity engagement (12,13). Moreover, physical activity measurement tools such as the International Physical Activity Questionnaire (IPAQ) may not fully capture activity intensity distribution or distinguish occupational, transport, and leisure domains, potentially obscuring important behavioural patterns relevant to functional mobility (14). Emerging work using 24-hour movement frameworks further emphasizes that reallocating sedentary time into moderate-to-vigorous activity produces measurable improvements in fitness outcomes, underscoring the importance of time-use composition rather than activity alone (15).

Despite these developments, limited research has focused specifically on the association between sedentary behaviour and functional mobility outcomes particularly gait speed and dynamic transfer performance in otherwise healthy university students, a population in which early behavioural risk accumulation may establish long-term trajectories of musculoskeletal dysfunction and mobility decline. Understanding whether functional mobility differs across sedentary exposure levels, even among students who meet moderate activity thresholds, has clear implications for campus-level prevention strategies, movement-break interventions, and physiotherapy-led behavioural counseling aimed at reducing prolonged sitting time. Therefore, the present study aimed to examine the relationship between sedentary behaviour and physical activity levels with functional mobility, assessed via the TUG test and 10-Meter Walk Test, among university students aged 18–25 years. The study hypothesis was that sedentary behaviour and physical activity levels would show a statistically significant association with functional mobility performance in this population (16).

MATERIALS AND METHODS

This cross-sectional observational study was conducted among university students at The University of Lahore over a six-month period. Participants were recruited using a convenience sampling approach from students enrolled in undergraduate programs, and recruitment occurred through in-person invitations and announcements within academic departments. Eligible students were aged 18–25 years, ambulatory without assistive devices, physically and cognitively capable of completing performance-based mobility assessments, and reported an average daily sedentary screen time of at least two hours. Students were excluded if they had a history of musculoskeletal or neurological disorders affecting mobility, any recent surgery or injury within the preceding 6–12 months, chronic medical conditions that could limit participation (e.g., uncontrolled diabetes, severe arthritis, cardiovascular disease), current use of walking aids, inability to comprehend study instructions due to language or cognitive barriers, or engagement in professional-level athletic training likely to skew activity patterns beyond typical student norms. Written informed consent was obtained from all participants prior to enrollment, and confidentiality was maintained by assigning participant identification codes and removing personal identifiers from analytic datasets. The study was conducted in accordance with ethical principles for human research and institutional research ethics procedures, consistent with the Declaration of Helsinki (17).

Sedentary behaviour was assessed using the Sedentary Behaviour Questionnaire (SBQ), a validated self-report tool that captures time spent in common sedentary domains across weekdays and weekends, enabling estimation of average hours per day spent sedentary (18). Sedentary time was operationalized as SBQ-derived hours/day and additionally categorized into quartiles (Q1–Q4) to permit categorical association testing across exposure gradients. Physical activity was measured using the International Physical Activity Questionnaire short form (IPAQ-SF), which estimates weekly minutes in walking, moderate-intensity, and vigorous-intensity activity and generates a total metabolic equivalent (MET-min/week) value; physical activity levels were categorized into standard IPAQ categories (low, moderate, high) based on established scoring criteria (19). Functional mobility was measured using two standardized tests: the Timed Up and Go (TUG) test and the 10-Meter Walk Test (10MWT). The TUG test was administered using a standard chair and a measured 3-meter walkway; participants were instructed to stand up, walk 3 meters at a comfortable speed, turn, return, and sit down, with time recorded in seconds. The TUG provides a clinically interpretable index of dynamic balance, transfer ability, and functional mobility and has demonstrated reliability and validity across a range of populations (20). The 10MWT was conducted on a marked 10-meter course; participants walked at their usual comfortable speed, and time was recorded to derive gait speed in meters/second. Gait speed is a sensitive marker of functional status and has demonstrated reliability in young adult populations (21).

Data collection was performed in a standardized manner by trained assessors. Participants first completed demographic and questionnaire measures (SBQ and IPAQ), followed by performance tests (TUG and 10MWT) conducted in a quiet hallway or designated testing area. To minimize bias, standardized verbal instructions were used for each test, the testing environment was kept consistent, and timing was recorded using a stopwatch. All data were entered into a structured database and screened for completeness and plausibility prior to analysis. To improve data integrity, double-checking of entries against original forms was performed on a random subset, and descriptive diagnostics were used to identify outliers and implausible values; no participant was excluded after enrollment, and complete-case analysis was used given the final dataset contained no missing values for the reported variables.

The sample size was calculated a priori using Epitools, yielding a required sample of 267 participants based on parameters suitable for cross-sectional association testing. Statistical analysis was performed using SPSS version 22. Continuous variables were summarized using means and standard deviations, while categorical variables were presented as frequencies and percentages. Associations between sedentary behaviour quartiles and walking speed categories were evaluated using Pearson's Chi-square test, and effect magnitude was quantified using Cramér's V with corresponding interpretation thresholds (small ≈0.10, medium ≈0.30, large ≈0.50). Assumptions for Chi-square testing were verified by confirming that no expected cell count was below five. For key associations, additional effect estimates were computed, including relative risks (RR) and odds ratios (OR) comparing the highest sedentary quartile (Q4) with the lowest quartile (Q1) for the probability of being classified as a normal (slower) walker, with 95% confidence intervals. Statistical significance was set at $p<0.05$ (two-sided) (22).

RESULTS

A total of 267 university students aged 18 to 25 years were included in the analysis. The mean age of participants was 21.53±2.25 years, reflecting a young adult cohort representative of the university student population. Sex distribution was nearly balanced, with 143 females (53.6%) and 124 males (46.4%), minimizing the potential for sex-related sampling imbalance in functional mobility outcomes. Descriptive results demonstrated that students reported a moderate sedentary exposure overall, with mean daily sedentary time of 6.14±2.43 hours/day (range 2.10–10.00 hours/day), indicating that prolonged sitting and sedentary routines were common in this population.

Physical activity levels assessed using the IPAQ showed that participants accumulated substantial weekly activity minutes, with mean walking time of 147.63±61.08 min/week (range 30–336 min/week), moderate-intensity activity of 130.06±48.62 min/week (range 20–266 min/week), and vigorous activity of 76.20±39.81 min/week (range 0–173 min/week). The mean total activity volume was 1616.90±434.25 MET-min/week (range 539–2930 MET-min/week), indicating overall moderate movement engagement at the group level. When categorized by standard IPAQ classifications, nearly all participants were classified as moderately active (266/267; 99.6%), while only one participant (0.4%) fell within the low physical activity category, demonstrating a highly homogeneous activity category distribution in the cohort. This suggests that while students generally met moderate physical activity criteria, the observed sedentary burden remained substantial, supporting the concept that sedentary exposure may coexist with adequate reported physical activity.

Functional mobility outcomes measured using standardized performance-based tests were largely preserved across the cohort. Mean performance on the Timed Up and Go (TUG) test was 9.52±0.81 seconds (range 7.29–11.64 seconds), consistent with expected functional transfer and balance performance in young adults. When categorized by clinical interpretation of mobility performance, 196 participants (73.4%) were classified within the normal range, whereas 71 participants (26.6%) were categorized as at risk, indicating that although the average mobility performance was normal, a meaningful minority demonstrated slower transfer or mobility performance within the TUG classification framework. Gait performance assessed using the 10-Meter Walk Test (10MWT) also indicated preserved ambulation, with mean gait speed of 1.33±0.12 m/s (range 0.98–1.60 m/s). When gait speed was categorized, the majority of participants were classified as having fast walking speed (220/267; 82.4%), while 47 participants (17.6%) were classified as normal walking speed, indicating that most students demonstrated gait performance above the normal speed threshold.

Sedentary behaviour exposure, categorized into SBQ quartiles, showed an approximately equal distribution across quartiles, enabling meaningful comparison of functional mobility outcomes across increasing sedentary exposure. The association between sedentary behaviour quartiles and walking speed category (fast vs normal) is presented in Table 2. Across all quartiles, fast walking speed predominated; however, the proportion of students classified as having normal (slower) walking speed increased with higher sedentary exposure, suggesting a potential gait performance shift associated with prolonged sitting. In the lowest sedentary quartile (Q1), 6 of 68 participants (8.8%) were classified as normal walkers, whereas in the highest sedentary quartile (Q4), 18 of 67 participants (26.9%) were classified as normal walkers. Notably, Q2 also demonstrated a relatively elevated prevalence of normal walking speed (16/67; 23.9%), while Q3 remained closer to Q1 (7/65; 10.8%). These findings indicate that the relationship between sedentary behaviour and gait category is not strictly linear across quartiles but demonstrates a consistent pattern of higher normal-speed prevalence in the higher sedentary categories, particularly Q4.

Table 1. Participant Characteristics, Sedentary Exposure, Physical Activity, and Functional Mobility Outcomes (N=267)

Domain	Variable	Mean ± SD / n (%)	Range
Demographics	Age (years)	21.53 ± 2.25	18–25
	Sex (Female)	143 (53.6%)	
	Sex (Male)	124 (46.4%)	
Sedentary behaviour	SBQ (hours/day)	6.14 ± 2.43	2.10–10.00
Physical activity (IPAQ)	Walking (min/week)	147.63 ± 61.08	30–336
	Moderate (min/week)	130.06 ± 48.62	20–266
	Vigorous (min/week)	76.20 ± 39.81	0–173
	Total MET-min/week	1616.90 ± 434.25	539–2930
	IPAQ category: Moderate	266 (99.6%)	
	IPAQ category: Low	1 (0.4%)	
Functional mobility	TUG (seconds)	9.52 ± 0.81	7.29–11.64
	10MWT gait speed (m/s)	1.33 ± 0.12	0.98–1.60
	TUG risk: Normal	196 (73.4%)	
	TUG risk: At risk	71 (26.6%)	
	Walking speed: Fast	220 (82.4%)	
	Walking speed: Normal	47 (17.6%)	

Table 2. Association Between Sedentary Behaviour Quartiles (SBQ) and Walking Speed Category (10MWT) With Embedded Inferential Statistics (N=267)

SBQ Quartile	Fast n (%)	Normal n (%)	Total n	Risk of Normal Speed (%)	OR vs Q1	95% CI (OR)	RR vs Q1	χ^2 (df)	Cramér's V	p-value
Q1 (Low)	62 (91.2)	6 (8.8)	68	8.8	Reference					
Q2	51 (76.1)	16 (23.9)	67	23.9	3.24	1.18–8.88	2.71			
Q3	58 (89.2)	7 (10.8)	65	10.8	1.25	0.39–4.00	1.22			
Q4 (High)	49 (73.1)	18 (26.9)	67	26.9	3.82	1.40–10.45	3.05			
Overall association			267					11.49 (3)	0.207	0.009

Inferential analysis confirmed that walking speed category differed significantly across sedentary quartiles. Pearson's Chi-square test identified a statistically significant association between SBQ quartile and walking-speed category (χ^2=11.49, df=3, p=0.009), indicating that the distribution of gait speed categories varied meaningfully by sedentary behaviour level. The effect size estimate using Cramér's V was 0.207, reflecting a small-to-moderate magnitude association, which is clinically relevant given the young age and generally preserved mobility of the cohort. The likelihood ratio test provided confirmatory evidence of robustness (11.84, df=3, p=0.008). Assumption checks confirmed statistical appropriateness of the Chi-square test, with no cells having expected counts <5 and a minimum expected cell count of 11.44, indicating that the observed association was not driven by sparse data or unstable contingency cells.

To quantify the direction and magnitude of sedentary-related gait changes, effect estimates comparing each sedentary quartile to the lowest quartile (Q1) were derived. Compared with Q1, students in Q4 had markedly increased likelihood of being classified as normal walkers, with an odds ratio (OR) of 3.82 and a 95% confidence interval (CI) of 1.40–10.45, indicating significantly higher odds of slower walking speed classification among those with the highest sedentary exposure. Relative risk estimates showed a similar pattern; students in Q4 had a 3.05-fold higher risk of normal walking speed compared with Q1 (RR=3.05). Elevated odds were also observed in Q2 relative to Q1 (OR=3.24; 95% CI 1.18–8.88; RR=2.71), while Q3 showed comparatively weaker and statistically uncertain association (OR=1.25; 95% CI 0.39–4.00; RR=1.22), consistent with its lower prevalence of normal-speed walking. Collectively, these results indicate that increased sedentary behaviour was associated with a significantly higher probability of being classified in the slower walking-speed category, despite the cohort's overall moderate physical activity classification and generally normal functional mobility performance.

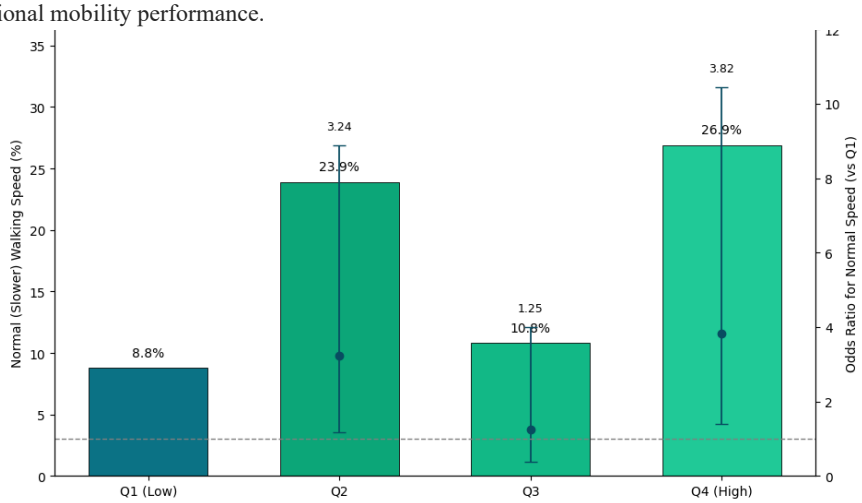

Figure 1 Sedentary Exposure Gradient and Gait Performance Shift in University Students

Figure 1 demonstrates a clear sedentary exposure gradient in gait-performance categorization, showing that the proportion of participants classified as normal (slower) walking speed increased from 8.8% in the lowest sedentary quartile (Q1) to 26.9% in the highest quartile (Q4), despite fast walking remaining predominant across quartiles. Compared with Q1, the odds of being a normal walker were markedly higher in Q2 (OR=3.24; 95% CI 1.18–8.88) and Q4 (OR=3.82; 95% CI 1.40–10.45), indicating a statistically meaningful shift toward slower gait performance at higher sedentary exposure, consistent with the significant overall association (χ^2=11.49, df=3, p=0.009; Cramér's V=0.207). The combined visualization highlights that gait-speed categorization worsens disproportionately in higher sedentary quartiles, suggesting early functional adaptation linked to prolonged sitting even within a generally active student cohort.

DISCUSSION

The present study examined the relationship between sedentary behaviour, physical activity levels, and functional mobility in university students aged 18–25 years. Although the cohort demonstrated largely preserved functional mobility and overwhelmingly moderate physical activity by self-report, sedentary exposure averaged over six hours daily and showed a statistically significant association with gait-speed categorization. These findings reinforce the growing evidence that sedentary behaviour is not merely the absence of physical activity but an independent behavioural risk factor capable of influencing functional outcomes even in young, otherwise healthy populations (23). Contemporary public health guidelines emphasize reducing sedentary time alongside increasing moderate-to-vigorous physical activity, acknowledging the distinct physiological pathways through which prolonged sitting may impair cardiometabolic and musculoskeletal health (23).

Sedentary exposure observed in this sample is consistent with multi-country university-student datasets reporting substantial daily sitting time attributable to academic demands and screen-based routines (24). The finding that nearly all participants were categorized as moderately active, yet still accumulated high sedentary time, echoes prior work showing that young adults can be simultaneously "active" and "sedentary," a pattern often concealed when physical activity is assessed using broad self-report instruments that do not fully capture movement fragmentation and prolonged sitting bouts (25). This dual behavioural profile is particularly relevant in university environments where walking between classes and routine campus movement may elevate IPAQ scores while long uninterrupted sitting dominates lecture and study time. The present results therefore support the behavioural epidemiology perspective that both activity and sitting must be assessed and targeted concurrently to protect functional health (23).

Functional mobility in this cohort, reflected by mean TUG and 10MWT values within normal ranges, aligns with systematic evidence that university students generally retain adequate physical fitness and functional capability due to intact neuromuscular reserve (26). Nevertheless, the significant association between sedentary quartiles and walking-speed category suggests that mobility-related effects of sedentary behaviour may emerge subtly before clinically overt impairment is detectable. This interpretation is consistent with longitudinal syntheses indicating that sedentary behaviour in young adults is associated with poorer physical fitness outcomes, including reduced cardiorespiratory and muscular fitness, even when other health markers show inconsistent associations (27). Importantly, 10MWT is widely recognized as a sensitive indicator of functional status and a marker that can reflect early neuromuscular inefficiency, reduced lower-limb power, and decreased movement economy changes that may be detectable within "normal" performance ranges before disability manifests (28).

Mechanistically, several pathways may explain why higher sedentary exposure is associated with a shift toward slower walking performance. Prolonged sitting is linked to reduced lower-limb muscle activation, impaired glucose and lipid metabolism, and compromised vascular function, all of which can influence exercise tolerance and locomotor efficiency (29). Additionally, sedentary routines contribute to musculoskeletal strain, altered spinal curvatures, and reduced trunk endurance, which can reduce postural efficiency and dynamic stability required during gait (30,31). University students frequently report screen-related postural problems and musculoskeletal discomfort, which may impair walking efficiency and

movement confidence during functional tasks, even in the absence of diagnosed pathology (32). The present study's observed pattern higher sedentary exposure coinciding with greater prevalence of normal (slower) gait speed fits the hypothesis that sedentary behaviour exerts cumulative effects on neuromuscular and postural systems important for functional mobility (31).

The significant sedentary–mobility association despite minimal variability in physical activity category is clinically and methodologically important. Because 99.6% of participants were classified as moderately active, there was limited between-group contrast to detect meaningful functional differences based on IPAQ category, and this homogeneity likely reduced the capacity to identify associations between physical activity classification and mobility outcomes. Prior studies have highlighted that IPAQ-based estimates may overestimate activity, and that self-report tools may insufficiently capture intensity, domain, and movement quality, especially when the behavioural environment is sedentary-dominant (25,33). This underscores the need for objective monitoring in future studies using accelerometry or device-based time-use composition analysis, which can quantify sedentary bouts, movement breaks, and vigorous activity distribution parameters increasingly recognized as relevant to functional and health outcomes (34).

From a preventive-health perspective, the present findings suggest that campus-level interventions should focus not only on encouraging exercise but also on reducing prolonged sitting time. Evidence indicates that prolonged sitting is associated with reduced well-being and fatigue, even among individuals who value physical activity, suggesting that addressing sedentary exposure has independent benefits beyond increasing weekly activity volume (35). Universities could implement structured movement-break policies during lectures, standing study areas, ergonomics education, and active learning strategies that reduce uninterrupted sitting. Encouraging active commuting may also increase daily energy expenditure and has been associated with improved perceived fitness and higher overall physical activity in university populations (36). Such strategies are particularly relevant because sedentary behaviours acquired during university years often persist into adulthood, potentially contributing to later musculoskeletal disorders and functional decline (37).

The study has several strengths, including the use of standardized mobility tests (TUG and 10MWT) alongside validated behavioural questionnaires, and a balanced sex distribution that reduces major sex-related sampling bias. However, limitations should be acknowledged when interpreting the findings. The cross-sectional design precludes causal inference, and reliance on self-reported sedentary behaviour and physical activity introduces potential recall bias and misclassification (25). Functional mobility was assessed using performance-based tests, but gait-speed classification remained categorical; future work may benefit from treating gait speed as a continuous outcome and examining dose–response relationships across sedentary exposure. Additionally, potential confounders such as BMI, sleep patterns, psychological stress, and musculoskeletal pain were not incorporated into adjusted models, although these factors are known to interact with activity behaviours and mobility (38,39). Despite these limitations, the findings contribute to the growing evidence that sedentary behaviour may exert measurable functional consequences in young adults and highlight the importance of reducing prolonged sitting even among moderately active students (23).

CONCLUSION

In university students aged 18–25 years, functional mobility was largely preserved and physical activity levels were predominantly moderate; however, sedentary behaviour showed a statistically significant association with gait performance, with higher sedentary exposure linked to an increased likelihood of slower walking-speed categorization. These findings support the view that sedentary behaviour is an independent behavioural risk factor that may influence mobility-related outcomes even in young, generally active populations, underscoring the importance of interventions that reduce prolonged sitting while maintaining and strengthening regular physical activity to protect long-term musculoskeletal function and mobility health.

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