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Sedentary Behavior and Sleep Quality in Guangdong Students Surveys

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Abstract:

The modern academic environment necessitates a rigorous examination of lifestyle factors that influence the well-being of young adults. This comprehensive study investigates the intricate relationship between sedentary behavior clustering and sleep quality among university students in Guangdong Province, a region characterized by rapid economic development and intense academic pressure. Utilizing a cross-sectional multi-center design, data were collected from a large, representative sample of university students across various disciplines. We applied Latent Class Analysis to categorize distinct typologies of sedentary behaviors, moving beyond traditional cumulative volume metrics to understand the contextual and behavioral nuances of prolonged sitting. The analysis identified several distinct clusters, including academically focused sedentary groups and leisure-screen dominated sedentary groups. Our findings reveal that not all sedentary behaviors impact sleep quality uniformly. Specifically, students exhibiting high volumes of screen-based leisure sedentary behavior before bedtime demonstrated significantly poorer sleep quality, as measured by standardized sleep indices, compared to those whose sedentary time was primarily academic and occurred during daylight hours. The results underscore the necessity for nuanced, context-specific public health interventions within higher education institutions. By understanding the specific clusters of sedentary behaviors that most detrimentally affect sleep architecture, university administrators and health policymakers can design targeted strategies aimed at mitigating adverse health outcomes and promoting better sleep hygiene among the student population.

1.INTRODUCTION

1.1 Background on Sedentary Behaviors in Higher Education

The transition from late adolescence to early adulthood is a critical developmental period marked by significant changes in lifestyle, social environment, and academic responsibilities. For university students, this transition frequently coincides with a pronounced increase in sedentary behaviors. Sedentary behavior is broadly defined as any waking behavior characterized by an energy expenditure of less than or equal to one and a half metabolic equivalents, primarily occurring while in a sitting, reclining, or lying posture. The contemporary university curriculum, which increasingly relies on digital platforms, extensive reading assignments, and long lectures, inherently promotes a highly sedentary lifestyle. Recent epidemiological data suggest that university students are among the most sedentary demographics within the general adult population, often accumulating excessive hours of sitting time daily [1]. This phenomenon is not merely a consequence of academic requirements but is also heavily influenced by modern recreational habits, which increasingly involve screen-based activities such as gaming, streaming media, and social networking [2]. The ubiquitous nature of smartphones, tablets, and personal computers has fundamentally altered how students interact with their environment, peers, and academic materials. Consequently, the boundary between academic sedentary time and recreational sedentary time has become increasingly blurred. Recognizing the complexity of these behaviors requires a shift from viewing sedentary time as a monolithic variable to understanding it as a multifaceted construct. Students do not simply sit; they engage in specific cognitive and psychological tasks while sitting, and the context of these tasks varies significantly. For instance, the physiological and psychological state of a student sitting in a library reading a textbook is markedly different from that of a student sitting in a dormitory playing competitive online video games late at night. Therefore, public health researchers have begun to emphasize the importance of examining the domains and contexts of sedentary behavior rather than just the total duration [3]. This conceptual shift is crucial for developing a precise understanding of how different types of sitting influence physiological and psychological health outcomes, particularly among young adults who are establishing long-term lifestyle habits.

1.2 Sleep Quality Dynamics among University Students

Sleep is a fundamental biological necessity that plays an indispensable role in physical restoration, cognitive consolidation, and emotional regulation. Despite its critical importance, poor sleep quality has emerged as a pervasive public health issue among university populations globally. Sleep quality is a complex, multidimensional construct that encompasses various quantitative and qualitative components, including sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. University students are particularly vulnerable to sleep disturbances due to a confluence of factors, including irregular academic schedules, peer influences, part-time employment, and heightened stress levels [4]. The consequences of compromised sleep are severe and far-reaching, encompassing impaired academic performance, weakened immune function, increased susceptibility to mental health disorders such as depression and anxiety, and a higher risk of metabolic dysregulation.

The relationship between waking lifestyle behaviors and subsequent sleep quality is an area of intense scientific inquiry. Extensive screen time, a major component of modern sedentary behavior, has been consistently linked to adverse sleep outcomes. The mechanisms underlying this relationship are multifaceted. The emission of blue light from digital screens is known to suppress the pineal gland secretion of melatonin, a hormone critical for the regulation of the circadian rhythm. Furthermore, the content of screen-based media, particularly interactive and emotionally stimulating content such as video games or social media debates, can lead to heightened psychological and physiological arousal, thereby increasing sleep latency and reducing overall

sleep efficiency [5]. However, the assumption that all forms of sedentary behavior are equally detrimental to sleep quality is overly simplistic and requires empirical validation. For example, sitting for long periods to engage in relaxing activities, such as reading a non-academic book or listening to calm music, may not elicit the same negative effects on sleep architecture as screen-based or highly stressful academic sitting [6].

1.3 Objectives and Hypotheses

This research is situated within the unique socio-cultural and economic context of Guangdong Province, China. Guangdong is one of the most economically dynamic and technologically advanced regions globally, characterized by rapid urbanization, a highly competitive academic environment, and ubiquitous digital connectivity. The universities in this region are known for their rigorous academic standards and intense pressure, which may exacerbate both sedentary behaviors and sleep disturbances among students [7]. The primary objective of this comprehensive study is to investigate the complex interplay between distinct clusters of sedentary behaviors and sleep quality among university students in Guangdong Province. To achieve this objective, we employ a person-centered analytical approach, specifically Latent Class Analysis, to identify homogenous subgroups of students based on their self-reported engagement in various domains of sedentary behavior. We hypothesize that distinct behavioral phenotypes, or clusters, will emerge, differentiating students based on their specific patterns of academic and recreational sitting. Furthermore, we hypothesize that these derived clusters will exhibit significantly different associations with overall sleep quality and its specific components. Specifically, we anticipate that clusters characterized by high volumes of late-night, screen-based recreational sedentary behavior will demonstrate the most profound impairments in sleep quality compared to clusters characterized by predominantly academic or low overall sedentary time [8]. By elucidating these context-specific associations, this study aims to provide a nuanced empirical foundation for the development of targeted, effective interventions to improve lifestyle behaviors and sleep health in higher education settings.

2. Literature Review

2.1 Conceptualizing Sedentary Behavior Clustering

The traditional paradigm in physical activity and sedentary behavior epidemiology has heavily relied on variable-centered approaches, typically operationalizing sedentary behavior as a continuous variable representing total daily sitting time. While this approach has been instrumental in establishing the independent health risks associated with prolonged sitting, such as increased cardiovascular morbidity and all-cause mortality, it fundamentally obscures the behavioral complexity of how sitting is accumulated throughout the day. In reality, individuals engage in a variety of sedentary tasks that often co-occur or cluster together in specific patterns [9]. For instance, an individual who spends significant time commuting in a vehicle may also be more likely to spend their evening hours watching television. Recognizing this complexity, recent public health literature has increasingly advocated for person-centered analytical techniques, such as cluster analysis and latent class analysis. Person-centered approaches aim to identify latent subgroups within a broader population based on shared response patterns across multiple behavioral indicators. In the context of sedentary behavior, this means categorizing individuals based on their unique profile of sitting activities, such as the combination of time spent on educational tasks, recreational screen time, socializing, and transportation. This conceptual shift is vital because behaviors do not exist in a vacuum; they interact synergistically or antagonistically to influence health outcomes. Previous studies utilizing clustering techniques in adolescent and young adult populations have consistently identified distinct typologies, such as techno-active groups, who display high screen time but also high physical activity, and completely sedentary groups, who exhibit high sitting time across all domains and low physical activity [10]. Applying

these methodologies allows researchers to move beyond the simplistic notion that all sitting is universally harmful and instead investigate whether the context, cognitive demand, and timing of the sedentary behavior modulate its physiological impact.

2.2 Biological and Psychological Links between Sedentary Time and Sleep

The intersection of sedentary behavior and sleep quality is governed by a complex web of biological, circadian, and psychological mechanisms. To understand why prolonged sitting might disrupt sleep, one must examine the specific activities undertaken during sedentary time. The most prominent mediating factor identified in contemporary literature is the use of screen-based electronic devices. The spectral composition of light emitted by modern light-emitting diode screens is heavily weighted towards the short-wavelength blue spectrum. Retinal ganglion cells containing melanopsin are exquisitely sensitive to this blue light, which signals the suprachiasmatic nucleus of the hypothalamus to inhibit the production of melatonin [11]. Melatonin is the principal endocrine orchestrator of the transition from wakefulness to sleep. Consequently, prolonged exposure to screens, particularly in the hours immediately preceding bedtime, directly shifts the circadian phase, delays sleep onset, and alters the architecture of sleep cycles. Beyond the purely photobiological effects, the psychological arousal associated with modern sedentary activities plays a critical role in sleep disruption. Many screen-based activities, such as competitive multiplayer gaming, engaging with anxiety-inducing news feeds, or participating in intense social media interactions, activate the sympathetic nervous system. This activation results in the release of stress hormones, including cortisol and adrenaline, elevating heart rate and core body temperature, physiological states that are fundamentally incompatible with the initiation and maintenance of deep sleep [12]. Furthermore, prolonged sitting, particularly in non-ergonomic postures common among students working on laptops on beds or couches, can lead to musculoskeletal discomfort, neck pain, and lower back pain. Such physical discomfort frequently causes micro-arousals during the night, fragmenting sleep and reducing the proportion of time spent in restorative slow-wave sleep. Conversely, some forms of sedentary behavior, such as reading a printed book or engaging in quiet contemplation, may facilitate psychological relaxation and serve as an effective transition into sleep, highlighting the necessity of distinguishing between different sedentary contexts [13].

2.3 The Context of Guangdong Province

Guangdong Province provides a highly relevant and unique epidemiological context for investigating these behavioral phenomena. As the vanguard of economic reform and technological manufacturing, Guangdong has experienced unprecedented urbanization and lifestyle modernization over the past four decades. The provincial culture places an exceptionally high premium on educational attainment and academic excellence, leading to highly competitive environments within its tertiary educational institutions. University students in Guangdong often face immense pressure to succeed academically to secure employment in a highly competitive job market [14]. This intense pressure frequently translates into extraordinary volumes of academic-related sedentary behavior, including extended hours of studying in libraries, attending long lectures, and conducting digital research. Simultaneously, the region is highly integrated into the global digital economy. High-speed internet access is ubiquitous, and smartphone penetration among young adults is virtually absolute. This technological immersion facilitates high levels of recreational screen time. Furthermore, the subtropical climate of Guangdong, characterized by long, hot, and highly humid summers, often discourages outdoor physical activity, inadvertently driving students towards indoor, climate-controlled, and predominantly sedentary recreational pursuits [15]. The combination of intense academic demands, ubiquitous digital entertainment, and environmental factors that promote indoor living creates a perfect storm for the proliferation of diverse and prolonged sedentary behaviors. Understanding how these behaviors cluster within this

specific population and how they impact sleep is essential for developing culturally and environmentally appropriate public health interventions tailored to the realities of rapidly modernizing Asian societies.

3. Methodology and Analysis

3.1 Study Design and Participant Recruitment

This research employed a cross-sectional, multi-center, stratified cluster sampling design to ensure a comprehensive and representative sample of the university student population in Guangdong Province. The sampling framework was meticulously constructed to capture the diversity of the higher education landscape within the region. We initially stratified the province into three primary tiers based on geographic and economic indicators: the highly developed Pearl River Delta core encompassing cities such as Guangzhou and Shenzhen; the intermediate developing regions; and the peripheral areas. From each tier, universities were randomly selected, ensuring a mix of comprehensive universities, specialized technical institutes, and medical colleges. Within each selected institution, academic departments and subsequent class cohorts were chosen using a random number generation protocol. The recruitment phase was conducted over a single academic semester to minimize seasonal variations in behavior and academic workload. Eligible participants were full-time undergraduate and postgraduate students aged between eighteen and twenty-nine years, currently residing in university dormitories or off-campus housing within the province. Exclusion criteria were rigorously applied to remove potential confounding variables. Individuals with clinically diagnosed sleep disorders such as sleep apnea or narcolepsy, those currently undergoing treatment for severe psychiatric conditions, and those with physical disabilities that fundamentally restrict mobility and dictate sitting time were excluded from the final analytical sample [16]. Prior to the initiation of data collection, the research protocol was thoroughly reviewed and approved by the central institutional review board for human subjects research. Comprehensive informed consent was obtained from all participants, detailing the voluntary nature of the study, the strict confidentiality of their responses, and their right to withdraw at any time without penalty. Table 1 provides a detailed breakdown of the demographic characteristics of the final sample utilized in this study.

Table 1: Demographic Characteristics of the Guangdong University Student Sample

Demographic Variable	Categorization	Frequency Count	Percentage Distribution
Gender Identity	Male	2150	48.6
Gender Identity	Female	2275	51.4
Academic Level	Freshman	1340	30.3
Academic Level	Sophomore	1285	29.0
Academic Level	Junior	1100	24.9
Academic Level	Senior and Postgraduate	700	15.8
Body Mass Index Category	Underweight	450	10.2
Body Mass Index Category	Normal Weight	3120	70.5
Body Mass Index Category	Overweight and Obese	855	19.3

3.2 Measurement Instruments

To capture the multidimensionality of the variables under investigation, a battery of validated self-report instruments was deployed through a secure, encrypted online survey platform. The primary exposure variable, sedentary behavior, was assessed utilizing an adapted version of the Sedentary Behavior Questionnaire specifically tailored for the university context. This instrument requires

participants to estimate the average amount of time spent engaging in nine distinct sedentary activities during a typical weekday and a typical weekend day over the preceding month. The activities assessed included sitting during lectures, studying or doing homework outside of class, watching television or streaming movies, playing video games, using a computer for non-academic leisure, sitting while socializing, sitting during transit, sitting while reading for pleasure, and performing administrative or part-time work tasks while sitting [17]. To ensure data quality, extreme outliers reporting implausible amounts of daily waking hours were truncated or excluded based on established epidemiological data cleaning protocols. The primary outcome variable, sleep quality, was measured using the globally recognized Pittsburgh Sleep Quality Index. This comprehensive instrument evaluates sleep patterns and disturbances over a one-month retrospective time interval. It consists of nineteen individual items that generate seven component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Each component is scored on a scale from zero to three, where zero indicates no difficulty and three indicates severe difficulty. The seven component scores are then summed to produce a global score ranging from zero to twenty-one. A global score exceeding the established threshold of five is conventionally interpreted as an indicator of clinically significant poor sleep quality [18]. In addition to the primary variables, a comprehensive suite of sociodemographic and lifestyle covariates was collected, including age, gender, subjective socioeconomic status, self-rated academic stress levels, dietary patterns, and moderate-to-vigorous physical activity levels, assessed via the short form of the International Physical Activity Questionnaire. Table 2 outlines the primary constructs measured and the specific domains captured by the survey instruments.

Table 2: Overview of Primary Measurement Constructs and Specific Assessment Domains

Construct Evaluated	Primary Assessment Tool	Specific Domains or Sub-components Measured
Sedentary Behavior Profile	Contextual Sedentary Questionnaire	Academic sitting, screen-based leisure, social sitting, transit time
Global Sleep Quality	Pittsburgh Sleep Quality Index	Sleep latency, duration, efficiency, daytime dysfunction, disturbances
Physical Activity Level	International Physical Activity Questionnaire	Walking, moderate activity, vigorous activity, weekly energy expenditure
Psychological State	Perceived Stress Scale	Academic pressure, financial anxiety, social relationship stress

3.3 Data Processing and Statistical Procedures

The analytical strategy was executed in several rigorous phases to ensure the robustness and validity of the findings. All data management and statistical analyses were performed using advanced statistical computing software. Initially, descriptive statistics were generated to characterize the sample, utilizing means and standard deviations for continuous variables conforming to a normal distribution, and frequencies and percentages for categorical variables. Bivariate relationships between individual sedentary domains and the global sleep quality score were explored using independent samples t-tests and Pearson correlation coefficients to establish baseline associations [19]. The core of the analysis relied on Latent Class Analysis to empirically derive clusters of students based on their sedentary behavior profiles. Latent Class Analysis is a probabilistic modeling approach that groups individuals into unobserved, discrete classes based on

their patterns of responses to measured indicator variables. In this study, the input indicators were the self-reported time spent in the various specific domains of sedentary behavior. We estimated a series of models specifying two through six latent classes. The determination of the optimal number of classes was not based on a single metric but rather a comprehensive evaluation of several model fit indices. We prioritized the Bayesian Information Criterion and the sample-size adjusted Bayesian Information Criterion, where lower values indicate superior model fit and parsimony. Furthermore, we assessed the Lo-Mendell-Rubin adjusted likelihood ratio test, which compares the fit of a model with a specified number of classes against a model with one fewer class, providing a statistical test for the improvement in fit. Entropy, a measure of classification certainty ranging from zero to one, was also evaluated, with values closer to one indicating that the classes are highly distinct and individuals are classified with high probability [20].

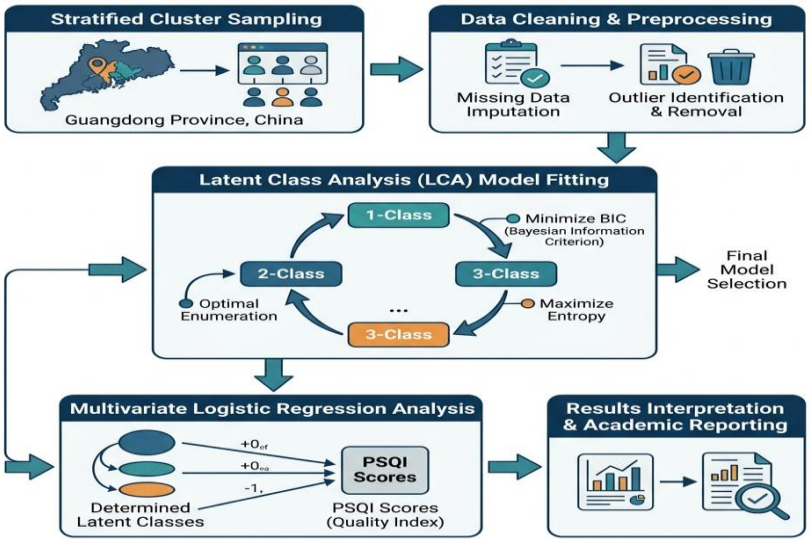


Figure 1: Methodological Flowchart of Data Processing and Latent Class Analysis

Once the optimal latent class model was finalized, each participant was assigned to the class for which they had the highest posterior probability of membership. This class membership variable then served as the primary independent variable in subsequent predictive models. To evaluate the independent association between the derived sedentary behavior clusters and sleep quality, we constructed a series of multivariate linear and logistic regression models. The continuous global sleep quality score was utilized in the linear models to assess the magnitude of the effect, while a binary categorization of good versus poor sleep quality was utilized in the logistic models to estimate adjusted odds ratios. These models were systematically adjusted for a comprehensive array of potential confounding variables, including age, gender, body mass index, academic year, total moderate-to-vigorous physical activity, and perceived academic stress, to isolate the specific impact of the sedentary behavioral profiles [21].

4. Results and Discussion

4.1 Characteristics of Sedentary Clusters

The evaluation of model fit indices during the Latent Class Analysis revealed that a four-class model provided the most parsimonious and interpretable representation of the data structure. The four-class solution demonstrated a significantly lower Bayesian Information Criterion compared to the two and three-class models, and while the five-class model showed a marginal decrease in the criterion, it resulted in small, theoretically ambiguous groups that lacked practical utility. Furthermore, the entropy value for the four-class model was exceptionally robust, indicating a high degree of classification precision. Based on the distinct patterns of item-response probabilities for

the various sedentary domains, the four derived classes were assigned descriptive labels reflecting their dominant behavioral characteristics. Class One, representing approximately thirty-five percent of the sample, was characterized by high volumes of time spent studying, reading for academic purposes, and attending lectures, with comparatively low engagement in screen-based leisure activities. This group was subsequently labeled the Academically Sedentary Cluster. Class Two, comprising twenty-eight percent of the cohort, exhibited a starkly different profile, reporting exceptionally high durations of television viewing, online gaming, and non-academic computer use, alongside moderate academic sitting. This group was designated the Screen-Leisure Sedentary Cluster. Class Three, which captured twenty-two percent of the students, was characterized by high reported durations across nearly all assessed sedentary domains, reflecting a pervasive pattern of physical inactivity throughout the day. This group was identified as the Multidomain High Sedentary Cluster. Finally, Class Four, constituting fifteen percent of the participants, reported the lowest overall sedentary time across all domains and demonstrated a higher propensity for active transport and physical activity. This group was labeled the Low Sedentary Active Cluster. Table 3 delineates the standardized mean hours spent in key sedentary activities for each of the four identified clusters.

Table 3: Standardized Mean Daily Hours in Specific Sedentary Domains by Latent Class Cluster

Sedentary Activity Domain	Academically Sedentary	Screen-Leisure Sedentary	Multidomain High	Low Sedentary Active
Academic Studying and Lectures	7.5	4.2	6.8	3.5
Recreational Screen and Gaming	1.5	6.5	5.5	1.8
Socializing while Sitting	1.0	2.5	3.2	1.2
Commuting and Transit	0.8	1.0	1.5	0.5

4.2 Association with Sleep Quality Indicators

The subsequent analysis focused on evaluating how these distinct behavioral typologies related to sleep outcomes. The unadjusted comparison of global sleep quality scores across the four clusters revealed highly significant variations. The Multidomain High Sedentary Cluster and the Screen-Leisure Sedentary Cluster exhibited the highest mean global scores, strongly indicating poorer overall sleep quality. Conversely, the Low Sedentary Active Cluster demonstrated the most favorable sleep profile. To rigorously test these associations while accounting for the complex web of confounding factors, multivariate logistic regression models were executed. The Low Sedentary Active Cluster was established as the reference category for all comparative analyses. The fully adjusted multivariate models, which controlled for demographic variables, body mass index, psychological stress, and physical activity levels, confirmed the robust predictive power of the sedentary clusters on sleep quality. Students categorized within the Screen-Leisure Sedentary Cluster demonstrated an adjusted odds ratio indicating they were more than twice as likely to experience clinically poor sleep quality compared to the reference group. Similarly, the Multidomain High Sedentary Cluster showed a profoundly elevated risk of sleep disturbances. Interestingly, the Academically Sedentary Cluster, despite recording high total volumes of daily sitting time, did not show the same magnitude of sleep impairment. While their risk for poor sleep was slightly elevated compared to the most active group, it was significantly lower than the risks observed in the screen-heavy clusters [22]. Table 4 presents the detailed results of the multivariate

logistic regression, highlighting the adjusted odds ratios and associated confidence intervals for the likelihood of reporting poor sleep quality.

Table 4: Multivariate Logistic Regression Assessing Risk of Poor Sleep Quality by Sedentary Cluster

Sedentary Behavioral Cluster	Adjusted Odds Ratio	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Low Sedentary Active (Reference)	1.00	Reference	Reference
Academically Sedentary	1.25	1.05	1.48
Screen-Leisure Sedentary	2.35	1.95	2.82
Multidomain High Sedentary	2.68	2.15	3.34

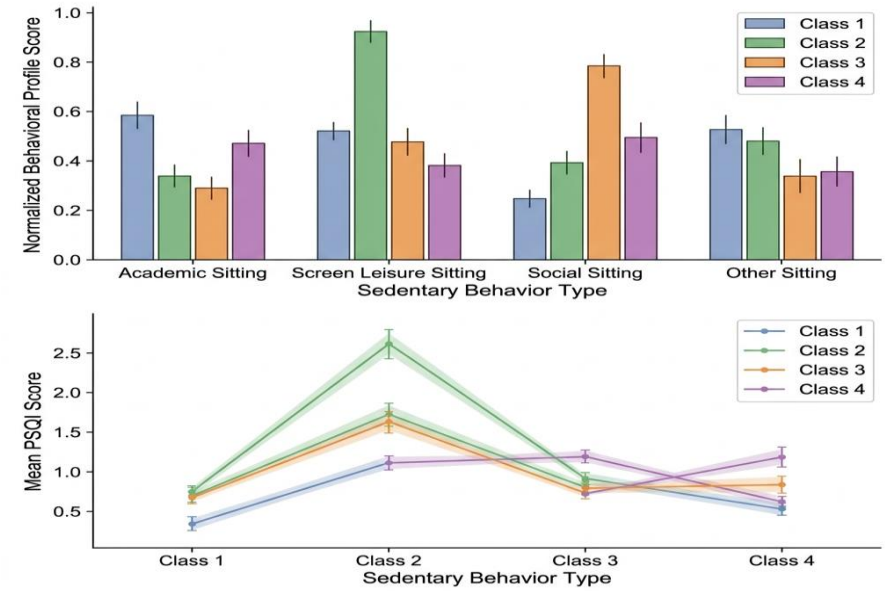


Figure 2: Comparative Profiles of Sedentary Behavior Clusters and Associated Sleep Disturbance Metrics

4.3 Discussion and Interpretations

The findings of this large-scale epidemiological investigation provide compelling evidence that treating sedentary behavior as a uniform variable is analytically insufficient and potentially misleading when examining complex physiological outcomes such as sleep quality. By applying Latent Class Analysis, we were able to deconstruct the sedentary habits of university students in Guangdong into meaningful, highly distinct behavioral phenotypes. The differential associations observed between these clusters and sleep architecture underscore the critical importance of the specific context and cognitive nature of sitting time. The pronounced deleterious effect observed in the Screen-Leisure Sedentary Cluster aligns closely with emerging chronobiological research. Activities dominant in this cluster, such as late-night gaming and continuous engagement with digital social networks, deliver a dual insult to the biological sleep system. First, the extended exposure to short-wavelength artificial light profoundly disrupts the natural diurnal rhythm of melatonin secretion, effectively signaling to the brain that it is still daytime. Second, the interactive and often emotionally valenced nature of these activities generates significant psychological and sympathetic nervous system arousal. This hyperarousal state is diametrically opposed to the parasympathetic dominance required for smooth transition into the initial stages of non-rapid eye movement sleep. Consequently, these students experience prolonged sleep latency, increased nocturnal awakenings, and a reduction in the restorative phases of sleep [23].

Conversely, the relatively benign sleep profile of the Academically Sedentary Cluster presents a fascinating nuance. While these students sit for extensive durations, their activities are generally daylight-dominated, conceptually structured, and less reliant on high-intensity, interactive screens compared to gaming or social media. Reading textbooks, attending lectures, and participating in study groups do not typically induce the acute sympathetic spikes associated with competitive online environments. Furthermore, if academic work is completed earlier in the day, the brain has adequate time to transition into a relaxed state prior to bedtime. However, it is imperative to note that this does not imply academic sitting is entirely harmless; it simply exerts a less acute disruptive effect on immediate sleep parameters compared to recreational screen time. These findings are highly relevant to the specific context of Guangdong Province, where intense academic competition often drives extreme study hours. The data suggest that while reducing total sitting time is an important long-term health goal, immediate interventions aiming to improve student well-being and academic performance should heavily prioritize the reduction of evening screen-based sedentary behaviors.

5. Conclusion

This comprehensive epidemiological study significantly advances our understanding of lifestyle behaviors in higher education settings by elucidating the complex, non-linear relationship between sedentary time and sleep quality among university students in Guangdong Province. Moving beyond simplistic cumulative metrics, the application of person-centered latent class methodologies successfully identified four distinct behavioral typologies: Academically Sedentary, Screen-Leisure Sedentary, Multidomain High Sedentary, and Low Sedentary Active. The central finding of this research is that the context and modality of sedentary behavior matter profoundly. Total sitting time alone is an inadequate predictor of sleep disruption. Instead, specific behavioral patterns, most notably high volumes of recreational, screen-based sitting, are overwhelmingly responsible for the degradation of sleep architecture. Students categorized within the screen-heavy clusters demonstrated a dramatically escalated risk of experiencing clinically significant poor sleep, characterized by prolonged latency and reduced efficiency, even after rigorous adjustment for an array of physiological and psychological confounders. In contrast, extensive sedentary time dedicated primarily to academic pursuits did not exhibit the same magnitude of sleep impairment, highlighting a crucial differentiation in how cognitive load, emotional arousal, and photobiological exposure interact during sitting time.

6. Implications for Public Health and University Policies

The nuanced insights generated by this research carry profound implications for the design and implementation of public health interventions and institutional policies within university environments. Blanket recommendations to simply "sit less" are likely to be ineffective and practically unfeasible in modern academic settings that inherently require significant stationary focus. Instead, health promotion strategies must become highly targeted. University administrators and campus health services should prioritize educational campaigns focused on digital hygiene and chronobiology, specifically emphasizing the severe neurobiological consequences of late-night screen exposure. Interventions could include implementing software-based blue light filters on campus network devices during evening hours or establishing localized dormitory policies that encourage quiet, non-digital activities before sleep. Furthermore, environmental redesign on campuses should reflect these findings. Integrating active workstations, such as standing desks or treadmill desks, into libraries and study halls could help mitigate the physiological impacts of the Academically Sedentary cluster without disrupting educational goals. Recognizing the specific pressures faced by students in highly competitive regions like Guangdong, comprehensive mental health support must be integrated with lifestyle interventions, acknowledging that excessive screen time is often utilized as a maladaptive coping mechanism for academic stress. Future longitudinal

research is urgently required to track these specific behavioral clusters over the complete trajectory of the university experience and to rigorously evaluate the efficacy of targeted, context-aware interventions aimed at fundamentally improving both the physical and sleep health of the next generation of professionals.

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