

ORIGINAL ARTICLE

Association between meeting the 24-hour movement guideline and anxiety status in Chinese school-aged adolescents

Zhou Xiaogang¹, Nor Shafrin Ahmad^{1,*}, Ahmad Zamri Khairani^{1,*}, Chen Yongqian¹

¹ School of Educational Studies, Universiti Sains Malaysia, Penang, 11800, Malaysia

*Correspondence: sham@usm.my, ahmadzamri@usm.my, zhouxiaogang@student.usm.my

ABSTRACT

Background/Objective: Adherence to the 24-hour movement guidelines (24-HMG) and various favorable health outcomes has been extensively documented; however, its relationship with anxiety among school-aged adolescents in China remains less explored. This study aims to examine the association between complying with the 24-HMG and anxiety status among school-aged adolescents in China. **Methods:** Cross-sectional data on movement behavior, encompassing physical activity, sedentary behavior, and sleep, were collected through the Health Behavior School-aged Children Survey from 670 adolescents (mean age = 13.57 ± 0.98). Anxiety was self-reported using the Self-Rating Anxiety Scale. Logistic regression was employed to assess the association between meeting the 24-HMG and anxiety status. **Results:** Only 2.1% of participants met all three 24-HMG, while 26.0% did not meet any of the recommendations. Additionally, 8.2% of participants reported experiencing anxiety. Logistic regression analyses indicated a significant association between adherence to the sedentary behavior guidelines (Odds Ratio [OR] = 0.301, $p < 0.05$), sleep guidelines (OR = 0.260, $p < 0.005$), or both (OR = 0.168, $p < 0.005$), and a reduced likelihood of anxiety compared to non-adherence. Conversely, adherence to none of the 24-HMG was significantly associated with an increased likelihood of anxiety (OR=3.343, $p < 0.05$), highlighting a greater probability of experiencing anxiety among these individuals compared to those who adhered to the guidelines. **Conclusion:** Only a minority of Chinese adolescents adhere to healthy movement behavior guidelines. It is important to consider the holistic approach of 24-HMG in mitigating anxiety among school-aged adolescents in China. Encouraging more high-quality research is essential to identify the correlates of movement behaviors in adolescents and design effective interventions.

Keywords: movement behaviors; physical activity; sedentary behavior; sleep; anxiety; school-aged adolescents; China

1. Introduction

Anxiety characterized by excessive fear or worry is considered to be among the most commonly occurring mental health disorders that typically develop in children and adolescents^[1,2]. Adolescence is a time of exploration and the development of a sense of self^[3], experiencing anxiety is likely to have a host of negative impacts on developmental outcomes (e.g., academic performance, impaired social relationships, peer relationships, and family life, interpersonal difficulties, and victimization, suicide-related behaviors)^[4-7]. Epidemiologic studies show that anxiety is a serious public health issue worldwide^[8], and identified as the

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sixth largest contributor to non-fatal health loss globally and consistently ranks among the top 10 causes of the years lived with disability in all WHO regions^[9]. According to the National Institutes of Health, it is estimated that nearly one-third of adolescents will experience anxiety and these numbers have been rising steadily^[10]. In China, recent evidence shows that 36.70% of adolescents exhibit anxiety-related symptoms, possibly due to a transitional stage of physical and psychological development, during which individuals are more sensitive to such life-threatening events^[11].

Over the past two decades, more and more physical activity guidelines have been released to help adolescents improve their well-being all over the world, such as UK, China, USA, Canada, etc.^[12-15]. However, the previous movement guidelines for adolescents have consistently concentrated too much on movement behavior, especially for the health benefit that moderate-to-vigorous-intensity physical activity (MVPA) confers. Indeed, regular participation in physical activity is widely regarded as an effective measure for preventing various health risk factors^[16,17]. A concern is that even adolescents who meet the current guideline of 60 min of MVPA per day may still have 23 h per day for other activities, such as schooling, sleeping, and discretionary time. It is revealed that physical activity (20%) only accounts for a small proportion of the 24-hour day, even in active adolescents. In contrast, sleep (40%), and sedentary behavior (40%) collectively account for approximately 80% of the day^[18]. Notably, it is also of great significance to meet non-movement behavior and sleep guidelines for an overall health benefit.

In 2016, Canada released the 24-Hour Movement Guidelines (24-HMG) for Children and Youth, offering guidance on physical activity, sedentary behavior, and sleep to obtain optimized health benefits^[19]. It is suggested that children and youth “Sweat, Step, Sleep and Sit,” indicating that a healthy 24 h for children and adolescents should include MVPA ≥ 60 mins; recreational screen time ≤ 2 h; sleep duration ≥ 9 h^[19] (**Figure 1**). This terminology represents a paradigm transformation that shifts from focusing on movement behaviors in isolation to the concept that “the whole day matters”. In the following years, many 24-HMG were introduced for different age groups worldwide^[20,21]. Collectively, these guidelines integrate physical activity, sedentary behavior, and sleep over a 24-hour period, which provides some comprehensive and scientific guidance on improving overall health.

In recent years, an increasing number of studies have highlighted a positive association between adherence to 24-HMG and various health outcomes, including academic performance^[22], suicidality^[23], obesity^[24], superior global cognition^[25], and improved mental health status^[26]. These studies contribute to a more comprehensive understanding of the relationship between meeting 24-HMG and health outcomes in a more holistic perspective. From the perspective of 24-hour movement behavior, recent studies have examined the association between 24-hour movement behavior and anxiety. For example, a cross-sectional study conducted on a nationally representative sample of US adolescents revealed that meeting all three 24-HMG was associated with a lower odds ratio for anxiety^[27]. Moreover, another cross-sectional study found that meeting none or only one of the 24-HMG is associated with a higher risk of anxiety while meeting any two guidelines effectively reduces anxiety^[28]. These emerging publications back up the positive impacts of satisfying the 24-HMG on anxiety. However, prior studies on the association between 24-HMG and mental health indicators have primarily focused on Western populations; however, little is known about associations between specific combinations of recommendations of the 24-HMG and anxiety status among Chinese adolescents. A comprehensive understanding of these specific and nuanced associations is crucial for developing effective interventions to reduce mental health problems such as anxiety burden in adolescents. Hence, the primary objective of this study is to examine the association between 24-hour movement behavior and anxiety among adolescents.

2. Materials and methods

The current observational, cross-sectional study was carried out among adolescents aged 12-16 years during the period of June to July 2022. Employing a convenience sampling strategy, middle school students were invited to partake in a paper-and-pencil survey. In this study, after removing cases with incomplete questionnaires and abnormal answers, 670 participants who provided valid information on variables were finally included for data analysis.

2.1. Study design and participants

This cross-sectional study was conducted from June to August 2022. Employing a convenience sampling approach, students from middle schools were asked to participate in a questionnaire-based investigation. The survey was uniformly administered within the classrooms with the prior consent of the school teachers. A total of 670 questionnaires were distributed, and after excluding incomplete and seemingly random responses, a collection of valid questionnaires was obtained. The effective recovery rate is determined based on the successfully gathered and usable responses.

2.2. Measures

2.2.1. Demographics

Demographic information reported by participants encompasses gender (male or female), age (in years), ethnicity (Han Chinese or minority), learning stages (primary school, junior high school), height (cm) and weight (kg), number of siblings (none/one or more), residential area (urban/rural), parental educational level (junior high school or below, senior high school, undergraduate, master's degree and above).

2.2.2. 24-hour movement behavior

24-hour movement behavior in this study was measured by using the Health Behavior in School-Aged Children (HBSC) questionnaire^[29]. The HBSC questionnaire is a reliable and valid assessment tool, encompassing physical activity, sedentary behavior, and sleep, with all high-reliability coefficients^[29].

2.2.3. Anxiety status

Anxiety status was assessed using the Zung's Self-Rating Anxiety Scale (SAS)^[30]. The SAS scale comprised 20 items, each rated on a 4-point Likert scale to assess the frequency of symptom occurrence. Each item is scored on a scale from 1 to 4, with higher scores indicating greater levels of anxiety. The scale measures anxiety levels over the past week, and the scoring method involves multiplying the raw score by 1.25 to obtain the standard score. A cutoff of 50 is used to distinguish between anxiety and non-anxiety states. Fifteen items in the scale use negative wordings and are scored on a 1 to 4 scale. The remaining five items use positive wordings and are scored in the reverse manner. The SAS is one of the most widely used anxiety test scales in China, demonstrating good validity among the Chinese adolescent population^[31,32].

2.3. Statistical analysis

All data analyses will be conducted using IBM SPSS Version 26.0. Descriptive statistics will be utilized to investigate the sample characteristics, the prevalence of meeting each recommendation individually, and the prevalence of various combinations. Statistical inferences were based on p values <0.05 and 95% confidence intervals (CIs). To investigate the association between 24-HMG and anxiety status, logistic regression models were developed. The first model concerned the association between the number of recommendations met within the 24-HMG and anxiety. The second model concerned the association between the specific combinations of recommendations the participant met within the 24-HMG and anxiety.

3. Results

3.1. Sample characteristics

The descriptive statistics of the study samples are summarized in **Table 1**. The study sample comprised a total of 670 participants, The sample consists of 57.2% boys and 42.8% girls, with a mean age of 13.57 years and a standard deviation of 0.98 years. The body mass index for the participants was reported as 19.23, with a standard deviation of 3.31. The majority of participants were from urban areas, accounting for 56.7%, while 43.3% were from rural areas, and 34.0% reported having siblings, whereas 66.0% did not. The study participants demonstrated diverse parental education levels. For fathers, 36.9% completed junior high school or below, 34.0% completed senior high school, 26.9% obtained an undergraduate education, and 2.2% held a Master's degree or higher. Regarding mothers, 51.8% had education up to junior high school, 27.2% completed senior high school, 19.3% had a college education, and 1.8% held a Master's degree or higher. The study participants demonstrated a spectrum of monthly incomes, with 34.5% falling in the ¥6001-10000 range, 24.5% earning between ¥10001-20000, and 19.3% reporting incomes from ¥3001-6000. Lower income brackets included 9.0% in the ¥20001-50000 range, 6.0% with incomes from ¥1501-3000, and 3.4% earning ¥1500 or less. A minimal fraction, 3.4%, reported monthly incomes of ¥50000 or more.

Table 1. Characteristics of the participants in this study (total = 670).

Category	N	%
Gender		
Boys	383	57.2%
Girls	287	42.8%
Age	13.57 ± 0.98	
BMI (Body Mass Index)	MBI = 19.23 ± 3.31	
Living Areas		
Urban	380	56.7%
Rural	290	43.3%
Siblings		
Yes	228	34.0%
No	442	66.0%
Father's education		
Junior high school or below	247	36.9%
Senior high school	228	34.0%
Undergraduate	180	26.9%
Master's degree and above	15	2.2%
Mother's education		
Junior high school and below	347	51.8%
Senior high school	182	27.2%
College	129	19.3%
Master's degree and above	12	1.8%
Monthly Household income		
¥1500 or less	23	3.4%
¥1500-3000	40	6.0%
¥3001-6000	129	19.3%

Table 1. (Continued).

Category	N	%
Monthly Household income		
¥6000-10000	231	34.5%
¥10001-20000	164	24.5%
¥20001-50000	60	9.0%
¥50000 or more	23	3.4%
Specific Combinations		
Only physical activity	10	1.5%
Only sedentary behavior	115	17.2%
Only sleep	172	25.7%
Physical activity + sedentary behavior	8	1.2%
Physical activity + sleep	24	3.6%
Sedentary behavior + sleep	153	22.8%
Meeting Numbers		
Meeting one	297	44.3%
Meeting two	185	27.6%
Meeting all	14	2.1%
Meeting none	174	26.0%
Anxiety Status		
Normal	615	91.8%
Anxiety	55	8.2%

The compliance rates of meeting specific combinations within the 24-HMG were displayed as follows (**Figure 1**): 1.5% for only physical activity, 17.2% for only sedentary behavior, and 25.7% for only sleep. Combined behaviors were observed, with 22.8% engaging in both sedentary behavior and sleep, 3.6% in both physical activity and sleep, and 1.2% in both physical activity and sedentary behavior. Additionally, 44.3% of participants adhered to one guideline, 27.6% adhered to any two guidelines, while 26.0% did not meet any of the guidelines, and a limited 2.1% met all three. The sample characteristics revealed that 91.8% exhibited normal anxiety levels, while 8.2% reported experiencing anxiety. This distribution highlights the prevalence of anxiety within the studied population.

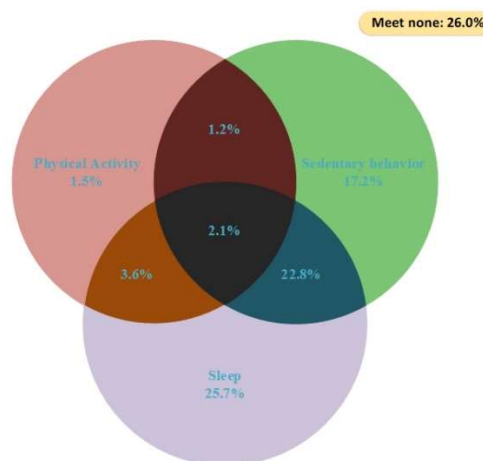


Figure 1. Compliance rates to the 24-HMG among adolescents.

3.2. Relationship between meeting specific combinations within 24-hour movement behavior and anxiety status in adolescents

The relationship between meeting the specific combinations within the 24-HMG and anxiety status is presented in **Table 2**. Logistic regressions unveiled that individuals who only adhered to sedentary behavior guidelines (OR = 0.301, $p < 0.05$) or sleep guidelines (OR = 0.260, $p < 0.005$) experienced significantly lower odds of anxiety compared to those who did not. Notably, individuals meeting both sedentary behavior and sleep guidelines (OR = 0.168, $p < 0.005$) displayed lower odds of anxiety than those who did not adhere to the guidelines.

Table 2. Relationship between meeting specific combinations of 24-HMG and anxiety in adolescents.

Specific combinations	β	OR	OR (95% CI)	p
Physical activity only	-2.694	0.586	0.066-5.225	0.632
Sedentary behavior only	-1.200	0.301	0.122-0.746	0.010
Sleep only	-1.347	0.260	0.113-0.597	0.001
Sedentary behavior +sleep	-1.786	0.168	0.060-0.467	0.001
Physical activity + sedentary behavior	-0.379	0.685	0.075-6.215	0.736
Physical activity + sleep	0.456	0.578	0.484-5.138	0.449

OR: Odd Ratio; CI: Confidence Interval.

3.3. Relationship between meeting numbers of recommendations within 24-HMG and anxiety status among adolescents

The relationship between the meeting numbers of the 24-HMG and anxiety status is presented in **Table 3**. Logistic regressions showed that adhering to none of the 24-HMG is linked with an increased likelihood of anxiety (OR = 3.343, $p < 0.05$) compared to those who met one or more of these guidelines.

Table 3. Relationship between meeting members of 24-hour movement behavior and anxiety in adolescents.

MeetingNumbers	β	OR	OR (95% CI)	p
All	0.172	1.187	0.13-10.843	0.879
None	1.207	3.343	1.511-7.397	0.003
One	-0.077	0.926	0.399-2.152	0.858
Two	0	-	-	-

OR: Odd Ratio; CI: Confidence Interval.

4. Discussion

The present study has delved into the relationships between meeting the 24-HMG and anxiety status among Chinese school-aged adolescents. The findings indicate that the prevalence rates of adherence to 24-HMG are not as optimistic as anticipated. Moreover, it has been revealed that meeting a greater number of 24-HMG is linked with reduced anxiety. This outcome suggests that strengthening compliance with 24-HMG might be an effective strategy in preventing mental health problems, especially for anxiety within this population.

The findings of this study indicate that the compliance rate with all three 24-hour movement behavior components among Chinese adolescents is lower than the averages observed in Canada and the United States^[33,34], yet remains at a relatively low level. Compared with outcomes from studies involving Chinese adolescent samples, the gradual decrease in compliance rates aligns with pertinent reports on 24-hour

movement behaviors^[28], underscoring the significance of adolescents as a focal point for interventions targeting suboptimal 24-hour movement behaviors.

Regarding individual movement behavior, compliance with the physical activity guidelines is associated with a reduced risk of anxiety. This finding echoes US research highlighting the crucial link between physical activity and anxiety within 24-hour movement behaviors, emphasizing the need to adhere to physical activity guidelines^[27]. Notably, the heightened compliance with sedentary behaviors and the comparatively lower adherence to physical activity highlights that contemporary adolescents predominantly exhibit sedentary tendencies and insufficient physical activity, emphasizing the need for tailored intervention strategies. Additionally, sleep duration exhibited a correlation with anxiety risk in both adolescent boys and girls, whereas the association between screen time and anxiety risk was significant solely within the urban adolescent group. Existing research based on college students suggests that sedentary behaviors such as watching TV, and movies, and using social media were identified as factors linked to higher odds of anxiety, whereas sedentary time on recreational reading was not associated with anxiety symptoms^[35]. Consequently, the correlation between screen time adherence and anxiety may be linked to adolescents' excessive use of electronic devices for educational activities. Future investigations should delve into discerning differences in the association between various forms of sedentary behaviors and health outcomes.

This study has revealed a significant relationship between the number of meeting 24-HMG and anxiety status among adolescents. MVPA, screen time, and sleep exhibit a collaborative impact on adolescent anxiety status, aligning with analogous research on Brazilian adolescents^[36]. Variations in adherence to movement behaviors altered the impact of the relationship with anxiety status. Positive modifications were observed among adolescents without anxiety who met the specific movement behavior targets.

To the best of our knowledge, this study represents one of the initial research into the potential correlation between 24-HMG and anxiety status with a specific focus on Chinese adolescents. The research contributes empirical evidence and practical implications. Nonetheless, it is essential to acknowledge potential limitations. The participants for the study were chosen through convenience sampling, potentially limiting the full representativeness of Chinese adolescents and thereby diminishing the generalizability of our findings. In addition, the utilization of self-reported measures for data collection may introduce recall and social desirability biases shaping the study's conclusions.

5. Conclusions

To conclude, our study offers valuable insights into the multifaceted relationship between meeting the 24-HMG and anxiety status among Chinese school-aged adolescents. The observed prevalence rates of adherence to specific combinations emphasize the diverse patterns of physical activity, sedentary behavior, and sleep duration among this demographic. Notably, a significant proportion of participants did not meet any of the recommended guidelines, underscoring the need for comprehensive intervention strategies. Furthermore, the identified correlation between meeting 24-HMG and anxiety levels highlights the potential role of lifestyle factors in influencing mental well-being. While a limited percentage of participants achieved the optimal balance across all three components, the majority demonstrated partial adherence or non-compliance. This suggests that promoting a holistic approach to 24-HMG, encompassing physical activity, sedentary behavior, and sleep, may contribute to mitigating anxiety status among school-aged adolescents. In the future, more high-quality longitudinal and experimental designs are essential to investigate the causal association further.

Abbreviations

MVPA = Moderate-to-vigorous-intensity physical activity; 24-HMG = 24-hour movement guidelines

Conflict of interest

The authors declare no conflict of interest.

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