

Overall behavior patterns of Chinese students and their associations with emotional and behavioral problems: A large-scale latent profile analysis

Qiqi Lai

Sun Yat-sen University

Wenxin Ge

Sun Yat-sen University

Liqing Yao

Sun Yat-sen University

Zhengge Jin

Sun Yat-sen University

Wanxin Wu

Sun Yat-sen University

Lixin Hu

Sun Yat-sen University

Yinhuan Guo

Sun Yat-sen University

Sichun Lin

Sun Yat-sen University

Jingyang Fang

Sun Yat-sen University

Yajun Chen

chenyj68@mail.sysu.edu.cn

Sun Yat-sen University

Research Article

Keywords: Emotional and behavioral problems, Students, Overall behavior patterns, Latent profile analysis

Posted Date: October 23rd, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11274405/v1>

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Additional Declarations: No competing interests reported.

Abstract

Background

Emotional and behavioral problems (EBPs) are increasingly common among students. However, previous research has largely focused on single behavioral factors rather than broader lifestyle constellations. This study aims to identify overall behavior patterns (OBPs) of different behaviors and explore their association with EBPs.

Methods

This study included 173,699 students aged 6–17 years from Guangzhou, China. Latent profile analysis was used to identify distinct OBPs across seven daily behavioral indicators: physical activity (PA) at different intensities, homework, television, digital device use, and sleep. EBPs were assessed by the parent-reported Strengths and Difficulties Questionnaire (SDQ). Logistic regression models were applied to examine the associations between OBPs and EBPs.

Results

Four OBPs were identified: Balanced-Control Group (83.58%), Physical-Active Group (4.52%), Academic-Overloaded Group (6.08%), and Screen-Excessive Group (5.81%). Compared with the Balanced-Control Group, the Academic-Overloaded Group (OR = 2.029, 95% CI: 1.928–2.136) and the Screen-Excessive Group (OR = 1.643, 95% CI: 1.557–1.734) were significantly linked to higher total difficulties score, with similar patterns across other SDQ dimensions ($p < 0.05$). The Physical-Active Group showed mixed associations. Stratified analyses revealed that these associations were moderated by gender, grade stage, and mother’s highest education level. Findings were robust in sensitivity analyses.

Conclusion

OBPs characterized by academic overload and overuse of digital devices are associated with EBPs among Chinese students. The coexistence of vigorous PA with psychosocial vulnerability underscores the need to consider OBPs within a broader socio-ecological context.

What is Known:

- Adolescent emotional and behavioral problems are linked to isolated lifestyle risks like excessive screen time, physical inactivity, and academic stress.

What is New:

- A large-scale person-centered analysis identifies four overall behavior patterns.
- Academic-Overloaded and Screen-Excessive profiles show significantly elevated risks for emotional and behavioral problems, moderated by gender, grade, and maternal education.

Abbreviations

- EBPs
emotional and behavioral problems
- ADHD
attention-deficit/hyperactivity disorder
- PA
physical activity
- SB
sedentary behavior
- LPA
latent profile analysis
- OBPs
overall behavior patterns
- COHERENCE
Children’s Growth Environment, Lifestyle, and Physical and Mental Health Development
- SDQ
Strengths and Difficulties Questionnaire
- TV
television
- AIC
Akaike Information Criterion
- BIC

Bayesian Information Criterion
LMRT
Lo-Mendell-Rubin Test
CNY
Chinese Yuan
SSBs
sugar-sweetened beverages
OR
odds ratios
CI
confidence intervals.

Introduction

Emotional and behavioral problems (EBPs) have emerged as a significant public health concern among children and adolescents worldwide. Meta-analyses evidence indicates that the pooled prevalence of mental disorders in this population reaches 13.4%[1]. In China, the prevalence of EBPs among children and adolescents has been reported to be as high as 15%-20%, with attention-deficit/hyperactivity disorder (ADHD), anxiety, and depressive symptoms being particularly prevalent[2-5]. These issues are not only transient distress but also associated with substantial impairments in academic performance, social functioning, and overall quality of life, imposing a long-term burden on individuals, families, and society[6-7]. Therefore, identifying modifiable lifestyle factors associated with EBPs is essential for developing effective prevention and intervention strategies.

Existing research has extensively explored the association between individual behavioral factors and mental health. Physical activity (PA) is generally considered protective[8], while sedentary behavior (SB), particularly recreational screen time, has been associated with increased risks of depression and anxiety[9-10]. Furthermore, PA of varying intensities and types may exert differential effects on depression risk[11-12]. Academic pressure is also widely recognized as a major contributor to poor mental health among children and adolescents[13-15]. However, these behaviors do not occur alone in daily life. They interact, compete, and substitute for one another in complex patterns, collectively forming an individual's "24-hour movement behavior"[16]. For example, prolonged academic homework may reduce time for PA and sleep, and different types of SB may exert distinct psychological effects[17]. Most previous studies predominantly adopt a variable-centered paradigm, focusing on the independent effects or simple summation of individual behaviors. This approach neglects the interactions and overall patterns among these behaviors and limits the development of comprehensive and personalized intervention strategies[18-19].

Latent profile analysis (LPA), as a person-centered statistical method, has been increasingly used to identify naturally occurring behavioral subgroups with internal consistency[20-21]. This approach helps move beyond examining single behaviors to understand the holistic effects of behavioral combinations and their relationship to mental health[22-23]. Although similar studies have been conducted among Western children with autism and ADHD [22] and students from a single college in China[24], there is still a lack of large-scale studies applicable to the wider population of children and adolescents at school. Moreover, the academic engagement had not been included in existing pattern studies, which was an indispensable part of students' daily lives. Therefore, investigating the overall behavior patterns (OBPs) of these activities and their links to EBPs in the unique context of contemporary China, characterized by intense academic competition intertwined with pervasive digitalization, is of substantial public health relevance.

This study aims to: 1) identify distinct OBPs using LPA based on students' engagement in PA, academic, screen use, and sleep within a large, population-based sample of Chinese students; 2) examine their associations with EBPs, while exploring whether these associations differ across key subgroups, such as gender, grade stage, and family socioeconomic status.

Methods

Data source and study population

This cross-sectional study used data from the 2019 survey of the Children's Growth Environment, Lifestyle, and Physical and Mental Health Development (COHERENCE) Project. The COHERENCE project started in 2016 in Guangzhou, China, and includes school-aged children and adolescents from all 11 districts of the city[25]. All participants were registered in a unified electronic health record system, which collects standardized data including demographic information, periodic physical examinations, physical fitness monitoring, and health questionnaires. We finally included 173,699 students aged 6-17 who completed all behavioral questions and the parent-reported Strengths and Difficulties Questionnaire (SDQ) in 2019 (**Fig. 1**). This study was approved by the Biomedical Ethics Committee of Sun Yat-sen University (L2016-010). All participants and their guardians provided informed consent forms.

Assessment of behavioral variables

Parents and children jointly completed a questionnaire assessing students' average daily duration of PA at different intensities, as well as the time spent on doing homework, watching television (TV), using digital devices (e.g., smartphones, computers, and iPads), and sleeping. All durations were converted to average daily minutes and standardized (z-scores). PA was assessed using a modified version of the International Physical Activity Questionnaire-Short Form (IPAQ-SF) [26]. Daily time for homework, TV, and device use was calculated from reported hours and minutes. Sleep duration was assessed using questions from the Children's Sleep Habits Questionnaire, with separate reports for school days and rest days, and averaged to a daily value.

Identification of OBPs

To identify relative combinations of OBPs, LPA was conducted on the z-scores of seven variables: vigorous PA, moderate PA, light PA, homework, TV, digital devices, and sleep. We systematically compared models specifying 1 to 6 latent profiles. The optimal number of profiles was determined by evaluating a combination of statistical fit indices and substantive interpretability. Specifically, lower values of the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) indicated better model fit; a significant adjusted Lo-Mendell-Rubin Test (LMRT) p-value ($p < 0.05$) indicated that the k-class model fit significantly better than the (k-1)-class model; and higher entropy values (> 0.8) indicated greater classification precision. In addition to these statistical criteria, the final model selection prioritized solutions with clear theoretical interpretability, distinct behavioral patterns across profiles, and adequate class sizes.

Assessment of EBPs

EBPs were assessed using the parent-reported version of the SDQ [27]. The SDQ is a widely used epidemiological instrument for evaluating children's emotional and behavioral problems over the preceding 6 months and has demonstrated acceptable reliability (Cronbach's alpha > 0.6) [28]. It consists of 25 items and includes five dimensions: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems and prosocial behavior. Scores for each dimension range from 0 to 10. Higher scores indicate more severe problems for emotional symptoms, conduct problems, hyperactivity/inattention, and peer relationship problems, whereas higher scores for prosocial behavior indicate more favorable functioning. The total difficulties score was calculated by summing the scores of the four factors excluding prosocial behavior, with a range of 0 to 40 and a higher score indicates a more severe level of EBPs. Internalizing problems were assessed by the sum of scores for emotional symptoms and peer relationship problems, while externalizing problems by the sum of scores for conduct problems and hyperactivity/inattention. Chinese normative standards were used to determine the severity of problems across the five dimensions and the total difficulties score [29]. Based on these standards, scores for each type of EBPs were categorized into three levels: normal, borderline, and abnormal. Consistent with previous studies [30-31], this study classifies scores for various EBPs into two categories: normal and borderline/abnormal.

Covariates

Based on previous studies [32], we adjusted for potential confounding factors. Demographic variables included: age (years), gender (boys, girls), only child status (yes, no) and grade stage (primary school, junior high school, senior high school). Socioeconomic variables included: parents' highest education level (junior high school or below, senior high school, college/ vocational college, bachelor's degree or higher), monthly household income ($< 5,000$ CNY, $5,000-7,999$ CNY, $8,000-11,999$ CNY, $\geq 12,000$ CNY, unknown). Parents' smoking status was categorized as never smoker, former smoker, or current smoker. Children's monthly cigarette consumption is indicated by the number of cigarettes smoked in the past month. Dietary status was assessed using a semi-quantitative food frequency questionnaire to evaluate the average daily consumption of vegetables, fruits, fried foods, alcohol and sugar-sweetened beverages (SSBs) over the past week.

Statistical Analysis

Continuous variables were expressed as mean $\pm$ standard deviation, and one-way ANOVA was used to compare differences among groups. Categorical variables were expressed as relative numbers (n) and percentages (%), and Pearson's Chi-square test was used to compare differences among groups. To address missing values in covariates (missingness ranged from 0% to 1.09% per variable), multiple imputation was performed using the MICE algorithm with 5 imputations, and all reported estimates were based on pooled results from analyses of the imputed datasets.

Logistic regression models were used to analyze the associations between different OBPs and EBPs. We established two hierarchical models: the crude model with no covariates adjusted, and the adjusted model adjusted for age, gender, only child status, parents' highest education level, monthly household income, parents' smoking status, children's monthly cigarette consumption and daily alcohol consumption. Results were presented as odds ratios (OR) with their 95% confidence intervals (CI). To examine heterogeneity in the association between OBPs and EBPs, we conducted stratified analyses and tested for multiplicative interactions by key variables including gender, only child status, grade stage, parents' highest education level, and monthly household income.

To assess the robustness of our findings, we conducted sensitivity analyses. First, we removed any missing data from the covariates and performed a logistic regression analysis to assess the robustness of the interpolation results. Second, we further adjusted for dietary factors, such as daily intake of vegetables, fruits, fried foods and SSBs, to observe whether the association between OBPs and EBPs changed. Statistical analysis was performed using R version 4.4.0. All tests were conducted at the two-tailed level, and a p-value < 0.05 was considered statistically significant.

Results

Classification of OBPs

Based on the combined evidence of optimal AIC/BIC, acceptable classification accuracy, interpretable and stable latent profiles, and avoidance of overfitting (Table S1), we selected the 4-class model as the most appropriate representation of OBPs in this cohort. Group 1 (Balanced-Control Group, 83.58%) was characterized by z-scores clustered around zero across all assessed activities, indicating a balanced and moderate allocation of time to PA, homework, screen use, and sleep, reflecting a self-regulated daily routine. Group 2 (Physical-Active Group, 4.52%) was distinguished by markedly elevated z-scores for moderate-to-vigorous PA, denoting a lifestyle heavily prioritizing physical exertion. Group 3 (Academic-Overloaded Group, 6.08%) was defined by the highest z-score for homework time and concomitant deficits in PA and sleep, reflecting a time-use pattern dominated by academic demands. Group 4 (Screen-Excessive Group, 5.81%) exhibited the most extreme z-scores for digital device and TV use, indicating a behavioral pattern centered on compulsive or excessive screen-based entertainment. (Fig. 2)

Baseline characteristics of the study population

Participants' basic characteristics across the four groups are presented in **Table 1**. The mean age of the participants was 10.14 ± 3.07 years, and 91,646 (52.76%) of them were boys. Among the four OBPs, the Balanced-Control Group had the largest proportion of participants (83.85%). The Physical-Active Group consisted of relatively younger students and had a higher representation of boys. Notably, the Academic-Overloaded Group showed a strong skew toward girl predominance, a majority of only children, and higher parental education. In contrast, the Screen-Excessive Group exhibited the highest proportions of senior high school students, lower parental education, lower household income, a higher rate of current smoking among parents, and a higher proportion of non-only children. In addition, the Screen-Excessive Group had the highest consumption of fried foods, SSBs, alcohol, and cigarettes. The abnormal rate of total difficulties score was 9.75% among all participants. Compared with other groups, the Academic-Overloaded Group had the highest abnormal rate of total difficulties score, while the Screen-Excessive Group had the highest borderline/abnormal rate. (**Table 2**)

Association between OBPs and EBPs

To examine the associations between OBPs and EBPs, multivariable logistic regression analyses were conducted (**Table 3**). Compared with the Balanced-Control Group, the Academic-Overloaded Group and the Screen-Excessive Group demonstrated significantly elevated ORs for all assessed dimensions of EBPs ($p < 0.001$). Specifically, the adjusted model revealed that the Academic-Overloaded Group was strongly associated with total difficulties score (OR = 2.014, 95% CI: 1.914-2.119), hyperactivity/inattention (OR = 2.165, 95% CI: 2.051-2.285), and peer relationship problems (OR = 1.653, 95% CI: 1.539-1.776). The Screen-Excessive Group was also associated with EBPs, most notably for emotional symptoms (OR = 1.744, 95% CI: 1.656-1.836), conduct problems (OR = 1.540, 95% CI: 1.468-1.615) and prosocial behavior (OR = 1.401, 95% CI: 1.340-1.465). In contrast, the Physical-Active Group showed a more complex and less pronounced pattern of associations in Adjusted model, showing a protective association with prosocial behavior (OR = 0.760, 95% CI: 0.721-0.802, $p < 0.001$) but lightly elevated OR on the emotional symptoms (OR = 1.096, 95% CI: 1.029-1.167, $p = 0.004$), with a non-significant association with total difficulties ($p = 0.428$). Sensitivity analyses further confirmed the findings and were largely consistent with the primary regression results (**Tables S2-S3**).

Stratified analyses

Table 4 presents the stratified analyses conducted on sociodemographic factors, which reveal heterogeneous associations between OBPs and the total difficulties score. Significant interactions were observed between OBPs and gender, grade stage and mother's highest education level (all p -values for interaction < 0.05).

In the Physical-Active Group, stratification by gender revealed that only girls showed higher ORs for total difficulties score (OR = 1.151, 95% CI: 1.039-1.274, $p = 0.007$), emotional symptoms (OR = 1.147, 95% CI: 1.046-1.257, $p = 0.003$), peer relationship problems (OR = 1.312, 95% CI: 1.140-1.510, $p < 0.001$) and internalizing problems (OR = 1.096, 95% CI: 1.019-1.179, $p = 0.014$). In the Academic-Overloaded Group, only students in primary school and junior high school had elevated ORs of total difficulties score, conduct problems, hyperactivity/inattention and peer relationship problems ($p < 0.01$). (**Tables S4-9**)

Regarding prosocial behavior, the elevated OR in the Academic-Overloaded Group was observed only among students whose mothers had a senior high school education or above, compared to the Balanced-Control Group ($p < 0.001$). For grade stage, the Academic-Overloaded Group was related to a higher OR of prosocial problems among primary school students (OR = 1.379, 95% CI: 1.290-1.473, $p < 0.001$), and was linked to a lower OR among senior high school students (OR = 0.887, 95% CI: 0.800-0.983, $p = 0.022$) (**Table S8**). Concerning externalizing problems, the lower OR associated with the Physical-Active Group was only evident among participants whose mothers held a Bachelor's degree or higher (OR = 0.833, 95% CI: 0.726-0.957, $p = 0.010$) (**Table S10**).

Discussion

This study employed LPA to identify four distinct OBPs among a large sample of Chinese students. Compared to the Balanced-Control Group, the Academic-Overloaded Group and Screen-Excessive Group were highly related to EBPs, while the Physical-Active Group demonstrated a more complex and less definitive association. Stratified analysis revealed that the association between the Academic-Overloaded Group and EBPs was primarily significant among primary and junior high school students. Conversely, the association between the Physical-Active Group and higher total difficulties score was observed only in girls, and its link to lower odds of externalizing problems was evident only among students whose mothers had a bachelor's degree or higher.

The Academic-Overloaded Group exhibited the strongest associations with elevated total difficulties score and nearly all SDQ sub-dimensions, even after extensive covariate adjustment. This group consisted predominantly of only children, and their parents generally had a high level of education. The pattern aligns with existing literature[33-34], which identifies high academic demands as a correlate of students' mental health difficulties in competitive educational settings. It may reflect higher educational expectations and performance pressure in families where parents have attained a certain level of education, potentially leading to a more competitive and less collaborative orientation in children[34]. Notably, the strength of the association suggests that academic-related stress may represent a persistent mental health concern, even amid broader educational reforms[15]. This could reflect variability in how policies are implemented or the internalization of achievement pressure as a prevailing social norm[35]. Students in the Academic-Overloaded Group reported not only the longest homework hours but also the shortest sleep duration and limited recreational screen time. This pattern, which sacrifices fundamental physiological recovery and leisure activities for the sake of a single extreme behavior, may constitute a multifaceted and compounded risk to adolescent mental health[36]. These findings highlight the value of examining academic pressure within the holistic perspective of students' daily behavioral patterns.

The Screen-Excessive Group was strongly associated with emotional symptoms, conduct problems, and prosocial behavior. This aligns with a growing body of evidence on the adverse psychosocial effects of excessive screen time[37-39]. Potential mechanisms include displacement of sleep and in-person social interaction, exposure to cyberbullying or idealized social comparisons, and the overstimulation of neural reward pathways, contributing to emotional dysregulation, impulsivity, and social skill deficits[40-41]. Notably, the concurrent socio-demographic disadvantages in this group include lower parental education, lower household income, and higher parental smoking rates. It was consistent with findings by Xiao et al.[42], suggesting that adverse social determinants of health often cluster with unhealthy behavioral patterns, creating a "double burden" on mental health. For instance, limited parental

supervision or resources for structured extracurricular activities in lower-income households may increase unsupervised screen time[41–43]. Meanwhile, the stress of economic hardship may drive adolescents to seek escape or solace in digital environments[38]. Therefore, interventions targeting screen addiction must also address the underlying family and socioeconomic context[44].

The Physical-Active Group did not demonstrate a clear protective effect against the total difficulties score, and its positive association with prosocial behavior is particularly noteworthy. This seemingly paradoxical finding challenges the simplistic linear assumption that PA is invariably beneficial for mental health[45]. Integrating the stratified analysis and demographic characteristics of this group, we propose the following explanations. First, the possibility of reverse causality cannot be ruled out. Students who already experience emotional or behavioral problems may be more inclined to engage in high-intensity PA as a form of self-regulation[46–47]. Second, the nature and quality of PA are critical. If the activity is compulsory, excessively competitive, or lacks social support, its potential mental health benefits may be negated or even become a source of additional stress[48–49]. It echoes the perspective that more may not always be better, suggesting that excessive or inappropriate engagement may be ineffective or even detrimental[50–51]. Third, vigorous PA may co-occur with other unmeasured or incompletely measured risk factors. For instance, children from high-stress family environments may engage in PA primarily as a means of emotional release or coping. In such cases, the mental health risks likely originate from the adverse social environment[2]. It underscores the importance of considering OBPs: a single health-promoting behavior may have its protective effects attenuated or masked when combined with other risk factors. This supports the necessity of adopting an integrated “24-hour movement behavior” framework in research[52–54].

A significant contribution of this study is the demonstration, via stratified analyses, of considerable heterogeneity in the associations between OBPs and EBPs. Specifically, the elevated ORs of the Academic-Overloaded Group were most pronounced among primary and junior high school students. It potentially reflects the forward shift of academic pressure and the relative scarcity of coping abilities in younger children[55]. In the Physical-Active Group, elevated odds for total difficulties score, emotional symptoms, and internalizing problems were observed exclusively among girls. This gender-specific vulnerability aligns with broader epidemiological patterns where adolescent girls report higher rates of internalizing disorders such as anxiety and depression[56]. It may reflect distinct psychosocial contexts in which girls may engage in PA under different social pressures or with differing motivations than boys, such as weight control, which could attenuate its mental health benefits[48]. The moderating role of maternal education on the association between the Physical-Active Group and externalizing problems highlights the pivotal role of the family environment in shaping the health returns of behaviors[57–58].

These findings collectively suggest that uniform intervention strategies are likely to be suboptimal. Future health programs could be more effective by considering both holistic behavioral patterns and key sociodemographic moderators. For younger students in the Academic-Overloaded Group, the aim of intervention should not be limited to reducing academic burden, but also focus on rebalancing their 24-hour daily routine. Schools and families can collaborate to convert displaced time from reduced homework into protected slots for sleep, unstructured play, and socialization[40]. For girls in the Physical-Active Group, gender-sensitive programming and education on healthy exercise practices are required[48], emphasizing enjoyment, skill mastery, and social connection over appearance or performance. For adolescents from lower socioeconomic backgrounds in the Screen-Excessive Group, addressing screen time in isolation is insufficient. It is essential to encourage meaningful offline alternatives, such as community sports and volunteering activities, which rely on strengthening peer networks and family support systems[59–60]. Interventions should be comprehensive and multi-level, combining academic load reduction, digital literacy education, family support, and the promotion of high-quality PA[61].

This study offers several notable methodological and conceptual advantages. First, it leverages a large, representative sample of students from China, enhancing the reliability of our findings. Second, the employment of LPA represents a person-centered approach that identifies distinct, empirically derived OBPs rather than imposing predefined categories, allowing for a more nuanced understanding of the heterogeneity in youth behavior and its psychological correlates. Third, the incorporation of stratified analyses by grade stage, maternal education, and socioeconomic status reveals important effect modifications, highlighting the contextual and social determinants underlying the observed associations.

However, limitations are inevitable. Firstly, the cross-sectional design precludes causal inference, and longitudinal studies are warranted to verify the direction of causality. Secondly, data relied on self-reports, which may be subject to recall bias and future research could incorporate objective measures[62]. Although multiple covariates were adjusted, residual confounding from unmeasured factors remains possible. Future studies could further assess important variables such as school climate and peer victimization, and explore their mediating mechanisms on mental health. Additionally, as the findings are based on a sample from a first-tier city in China, caution is advised when generalizing to other regions. Future research in more diverse settings would help build a broader framework for promoting children’s mental health.

Conclusion

This study confirms that naturally occurring Academic-Overloaded Group and Screen-Excessive Group are strongly associated with psychosocial difficulties among Chinese students. The association of the Physical-Active Group with EBPs is complex and context-dependent, underscoring that high levels of PA do not automatically confer mental health benefits and may co-occur with vulnerabilities. Intervention strategies should move beyond targeting individual behaviors to address overall behavior patterns and their underlying determinants.

Declarations

Competing interests

The authors declare that they have no conflicts of interest.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Biomedical Ethics Committee of Sun Yat-sen University (L2016-010).

Consent to participate

Informed consent was obtained from all participants and their guardians.

Funding

This work was supported by the National Natural Science Foundation of China (No. 82273650).

Author Contribution

Qiqi Lai and Ya-jun Chen contributed to the design and concept of the manuscript. Lixin Hu, Yinhuan Guo, Sichun Lin, and Jingyang Fang participated in collecting data. Qiqi Lai was responsible for conducting statistical analyses and manuscript drafting. Wenxin Ge, Liqing Yao, Zhengge Jin, Wanxin Wu, and Yinhuan Guo were responsible for the critical revision of the manuscript for intellectual content. All authors read and approved the final manuscript. Ya-jun Chen is the corresponding author, has full access to all the data and has final responsibility for the decision to submit for publication.

Acknowledgement

We sincerely appreciate all the children, parents, and workers who were involved in the study.

Data Availability

The survey is not publicly available, and participants were protected under a certificate of confidentiality issued by the Government of Guangzhou because of the sensitive nature of the data collected from all the student groups in Guangzhou city. Requests to assess the dataset from qualified researchers trained in human participant confidentiality protocols may be sent to the School of Public Health, Medical College of Sun Yat-Sen University, at chenyj68@mail.sysu.edu.cn.

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Tables

Table 1 Baseline characteristics of the study population (n=173,699)						
Variables	Overall	Balanced-Control Group	Physical-Active Group	Academic-Overloaded Group	Screen-Excessive Group	p
N (%)	173,699 (100%)	145,183 (83.85%)	7,859 (4.52%)	10,565 (6.08%)	10,092 (5.81%)	
Age, years	10.14 ± 3.07	9.77 ± 2.91	10.66 ± 2.93	12.25 ± 3.15	12.93 ± 2.88	<0.001
Gender, n (%)						<0.001
Boys	91,646 (52.76%)	77,006 (53.04%)	4,755 (60.50%)	4,837 (45.78%)	5,048 (50.02%)	
Girls	82,053 (47.24%)	68,177 (46.96%)	3,104 (39.50%)	5,728 (54.22%)	5,044 (49.98%)	
Grade stage, n (%)						<0.001
Primary school	109,826 (69.39%)	98,641 (74.37%)	4,488 (62.34%)	3,999 (42.27%)	2,698 (30.05%)	
Junior high school	32,675 (20.64%)	24,669 (18.60%)	2,069 (28.74%)	2,755 (29.12%)	3,182 (35.45%)	
Senior high school	15,780 (9.97%)	9,334 (7.04%)	642 (8.92%)	2,707 (28.61%)	3,097 (34.50%)	
Only child status, n (%)						<0.001
Yes	59,712 (34.38%)	49,776 (34.29%)	2,409 (30.65%)	4,377 (41.43%)	3,150 (31.21%)	
No	113,987 (65.62%)	95,407 (65.71%)	5,450 (69.35%)	6,188 (58.57%)	6,942 (68.79%)	
Father's highest education level, n (%)						<0.001
Junior high school or below	43,225 (24.89%)	33,225 (22.88%)	2,647 (33.68%)	2,509 (23.75%)	4,844 (48.00%)	
Senior high school	45,419 (26.15%)	37,320 (25.71%)	2,412 (30.69%)	2,671 (25.28%)	3,016 (29.89%)	
Vocational college	34,320 (19.76%)	29,675 (20.44%)	1,325 (16.86%)	2,101 (19.89%)	1,219 (12.08%)	
Bachelor's degree or above	50,735 (29.21%)	44,963 (30.97%)	1,475 (18.77%)	3,284 (31.08%)	1,013 (10.04%)	
Mother's highest education level, n (%)						<0.001
Junior high school or below	46,589 (26.82%)	35,561 (24.49%)	2,904 (36.95%)	2,701 (25.57%)	5,423 (53.74%)	
Senior high school	42,219 (24.31%)	35,072 (24.16%)	2,136 (27.18%)	2,487 (23.54%)	2,524 (25.01%)	
Vocational college	38,971 (22.44%)	33,740 (23.24%)	1,509 (19.20%)	2,424 (22.94%)	1,298 (12.86%)	
Bachelor's degree or above	45,920 (26.44%)	40,810 (28.11%)	1,310 (16.67%)	2,953 (27.95%)	847 (8.39%)	
Monthly household income, n (%)						<0.001
<5,000 CNY	64,001 (36.85%)	51,990 (35.81%)	3,185 (40.53%)	3,811 (36.07%)	5,015 (49.69%)	
5,000–7,999 CNY	37,787 (21.75%)	31,995 (22.04%)	1,620 (20.61%)	2,187 (20.70%)	1,985 (19.67%)	
8,000–11,999 CNY	24,536 (14.13%)	20,927 (14.41%)	1,042 (13.26%)	1,567 (14.83%)	1,000 (9.91%)	
≥12,000 CNY	32,807 (18.89%)	28,457 (19.60%)	1,269 (16.15%)	2,024 (19.16%)	1,057 (10.47%)	
Unknown	14,568 (8.39%)	11,814 (8.14%)	743 (9.45%)	976 (9.24%)	1,035 (10.26%)	
Father's smoking status, n (%)						<0.001
Never smoker	83,462 (48.05%)	71,024 (48.92%)	3,424 (43.57%)	5,259 (49.78%)	3,755 (37.21%)	
Former smoker	19,798 (11.40%)	16,336 (11.25%)	906 (11.53%)	1,311 (12.41%)	1,245 (12.34%)	
Current smoker	70,439 (40.55%)	57,823 (39.83%)	3,529 (44.90%)	3,995 (37.81%)	5,092 (50.46%)	
Mother's smoking status, n (%)						<0.001
Never smoker	171,716 (99.11%)	143,655 (99.18%)	7,737 (98.70%)	10,433 (99.02%)	9,891 (98.45%)	
Former smoker	797 (0.46%)	633 (0.44%)	39 (0.50%)	55 (0.52%)	70 (0.70%)	
Current smoker	747 (0.43%)	550 (0.38%)	63 (0.80%)	48 (0.46%)	86 (0.86%)	
Vigorous PA, min/day	23.16 ± 29.17	19.21 ± 20.29	99.14 ± 59.25	16.96 ± 19.98	27.34 ± 28.07	<0.001
Moderate PA, min/day	24.62 ± 31.81	19.95 ± 20.93	118.79 ± 58.57	17.32 ± 20.61	26.08 ± 26.80	<0.001
Light PA, min/day	39.17 ± 56.81	33.92 ± 48.16	98.06 ± 100.56	42.58 ± 60.45	65.21 ± 81.78	<0.001
Homework, min/day	139.11 ± 63.33	128.35 ± 50.53	148.38 ± 64.71	277.87 ± 44.60	141.41 ± 71.18	<0.001
TV, min/day	32.53 ± 38.19	30.40 ± 34.11	42.55 ± 44.11	16.65 ± 27.78	71.98 ± 63.84	<0.001

Electronic devices, min/day	40.71 ± 47.00	31.03 ± 28.09	46.81 ± 43.73	37.04 ± 34.05	179.02 ± 58.76	<0.001
Sleep, min/day	564.21 ± 73.96	568.37 ± 68.58	567.72 ± 80.48	511.65 ± 66.52	556.72 ± 116.70	<0.001
Vegetables, n/day	3.10 ± 2.99	3.03 ± 2.90	3.68 ± 3.49	3.41 ± 3.27	3.33 ± 3.44	<0.001
Fruits, n/day	2.10 ± 2.01	2.08 ± 1.95	2.64 ± 2.59	2.01 ± 1.99	2.08 ± 2.32	<0.001
Fried foods, times/day	0.11 ± 0.14	0.11 ± 0.13	0.13 ± 0.15	0.11 ± 0.14	0.16 ± 0.17	<0.001
SSBs, ml/day	57.02 ± 84.00	53.16 ± 78.09	70.37 ± 100.94	61.01 ± 91.03	98.07 ± 122.75	<0.001
Alcohol, ml/day	0.97 ± 8.43	0.77 ± 7.15	1.68 ± 12.49	0.95 ± 8.06	3.27 ± 17.06	<0.001
Cigarettes, n/mouth	0.12 ± 3.42	0.11 ± 3.37	0.15 ± 3.44	0.07 ± 2.58	0.22 ± 4.59	<0.001
Note: Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as relative numbers (n) and percentage						
Abbreviations: CNY: Chinese Yuan; PA: physical activity; TV: television; SSBs: sugar-sweetened beverages.						

Table 2 The SDQ classification of EBPs among participants in four groups (n=173,699)

Variables	Overall	Balanced-Control Group	Physical-Active Group	Academic-Overloaded Group	Screen-Excessive Group	p value
Emotional symptoms						<0.001
Normal	146,362 (84.26%)	123,698 (85.20%)	6,601 (83.99%)	8,342 (78.96%)	7,721 (76.51%)	
Borderline	12,634 (7.27%)	10,245 (7.06%)	564 (7.18%)	930 (8.80%)	895 (8.87%)	
Abnormal	14,703 (8.46%)	11,240 (7.74%)	694 (8.83%)	1,293 (12.24%)	1,476 (14.63%)	
Conduct problems						<0.001
Normal	133,125 (76.64%)	111,995 (77.14%)	6,057 (77.07%)	7,812 (73.94%)	7,261 (71.95%)	
Borderline	22,745 (13.09%)	18,922 (13.03%)	949 (12.08%)	1,420 (13.44%)	1,454 (14.41%)	
Abnormal	17,829 (10.26%)	14,266 (9.83%)	853 (10.85%)	1,333 (12.62%)	1,377 (13.64%)	
Hyperactivity/inattention						<0.001
Normal	147,572 (84.96%)	123,503 (85.07%)	6,779 (86.26%)	8,543 (80.86%)	8,747 (86.67%)	
Borderline	11,855 (6.83%)	9,924 (6.84%)	489 (6.22%)	787 (7.45%)	655 (6.49%)	
Abnormal	14,272 (8.22%)	11,756 (8.10%)	591 (7.52%)	1,235 (11.69%)	690 (6.84%)	
Peer relationship problems						<0.001
Normal	162,506 (93.56%)	136,600 (94.09%)	7,284 (92.68%)	9,596 (90.83%)	9,026 (89.44%)	
Borderline	7,501 (4.32%)	5,799 (3.99%)	391 (4.98%)	612 (5.79%)	699 (6.93%)	
Abnormal	3,692 (2.13%)	2,784 (1.92%)	184 (2.34%)	357 (3.38%)	367 (3.64%)	
Prosocial behavior						<0.001
Normal	123,063 (70.85%)	103,230 (71.10%)	5,949 (75.70%)	7,390 (69.95%)	6,494 (64.35%)	
Borderline	30,890 (17.78%)	25,887 (17.83%)	1,228 (15.63%)	1,735 (16.42%)	2,040 (20.21%)	
Abnormal	19,746 (11.37%)	16,066 (11.07%)	682 (8.68%)	1,440 (13.63%)	1,558 (15.44%)	
Internalizing problems						<0.001
Normal	91,410 (52.63%)	78,331 (53.95%)	4,100 (52.17%)	4,837 (45.78%)	4,142 (41.04%)	
Borderline	64,910 (37.37%)	53,611 (36.93%)	2,913 (37.07%)	4,203 (39.78%)	4,183 (41.45%)	
Abnormal	17,379 (10.01%)	13,241 (9.12%)	846 (10.76%)	1,525 (14.43%)	1,767 (17.51%)	
Externalizing problems						<0.001
Normal	127,058 (73.15%)	106,623 (73.44%)	5,839 (74.30%)	7,369 (69.75%)	7,227 (71.61%)	
Borderline	31,558 (18.17%)	26,355 (18.15%)	1,346 (17.13%)	1,904 (18.02%)	1,953 (19.35%)	
Abnormal	15,083 (8.68%)	12,205 (8.41%)	674 (8.58%)	1,292 (12.23%)	912 (9.04%)	
Total difficulties score						<0.001
Normal	145,958 (84.03%)	123,113 (84.80%)	6,622 (84.26%)	8,308 (78.64%)	7,915 (78.43%)	
Borderline	10,810 (6.22%)	8,821 (6.08%)	449 (5.71%)	751 (7.11%)	789 (7.82%)	
Abnormal	16,931 (9.75%)	13,249 (9.13%)	788 (10.03%)	1,506 (14.25%)	1,388 (13.75%)	
Abbreviations: SDQ: Strengths and Difficulties Questionnaire; EBPs: emotional and behavioral problems.						

Table 3 Association between OBPs and SDQ sub-dimensions in 173,699 students [OR (95%CI)]

Categories	Balanced-Control Group	Physical-Active Group
Emotional symptoms		
Crude model	Reference	1.097 (1.031-1.167)
Adjusted model	Reference	1.096 (1.029-1.167)
Conduct problems		
Crude model	Reference	1.004 (0.951-1.060)
Adjusted model	Reference	1.020 (0.966-1.077)
Hyperactivity/inattention		
Crude model	Reference	0.908 (0.850-0.969)
Adjusted model	Reference	0.951 (0.889-1.018)
Peer relationship problems		
Crude model	Reference	1.256 (1.151-1.371)
Adjusted model	Reference	1.104 (1.010-1.206)
Prosocial behavior		
Crude model	Reference	0.790 (0.749-0.833)
Adjusted model	Reference	0.760 (0.721-0.802)
Internalizing problems		
Crude model	Reference	1.074 (1.027-1.124)
Adjusted model	Reference	1.031 (0.984-1.080)
Externalizing problems		
Crude model	Reference	0.957 (0.908-1.008)
Adjusted model	Reference	0.985 (0.934-1.039)
Total difficulties score		
Crude model	Reference	1.042 (0.979-1.109)
Adjusted model	Reference	1.026 (0.963-1.093)

Note: The crude model did not adjust for any covariate. The adjusted model adjusted for age, gender, only child status, parents' highest education level, monthly household income, parents' smoking status, and parents' drinking status.

Abbreviations: OR: odds ratios; CI: confidence intervals; OBPs: overall behavior patterns; SDQ: Strengths and Difficulties Questionnaire.

Table 4 Stratified analyses of OBPs and total difficulties score in 173,699 students [OR (95%CI)]

Variables	Balanced-Control Group	Physical-Active Group
Gender		
Boys	Reference	0.966 (0.891-1.048)
Girls	Reference	1.151 (1.039-1.274)
Only child status		
Yes	Reference	1.071 (0.953-1.203)
No	Reference	1.005 (0.932-1.084)
Grade stage		
Primary school	Reference	0.998 (0.922-1.080)
Junior high school	Reference	1.049 (0.915-1.203)
Senior high school	Reference	1.030 (0.772-1.373)
Father's highest education level		
Junior high school or below	Reference	1.023 (0.921-1.135)
Senior high school	Reference	1.070 (0.955-1.199)
Vocational college	Reference	1.072 (0.918-1.251)
Bachelor's degree or above	Reference	0.910 (0.770-1.076)
Mother's highest education level		
Junior high school or below	Reference	1.058 (0.957-1.170)
Senior high school	Reference	1.037 (0.918-1.173)
Vocational college	Reference	1.000 (0.864-1.157)
Bachelor's degree or above	Reference	0.949 (0.799-1.127)
Monthly household income		
<5,000 CNY	Reference	1.020 (0.928-1.121)
5,000–7,999 CNY	Reference	1.061 (0.923-1.221)
8,000–11,999 CNY	Reference	0.998 (0.830-1.201)
≥12,000 CNY	Reference	0.988 (0.826-1.183)

Note: All analyses were adjusted for age and gender, only child status, parents' highest education level, monthly household income, parents' smoking status, and parents' drinking status.

Abbreviations: OBPs: overall behavior patterns; OR: odds ratios; CI: confidence intervals; CNY: Chinese Yuan.

Figures

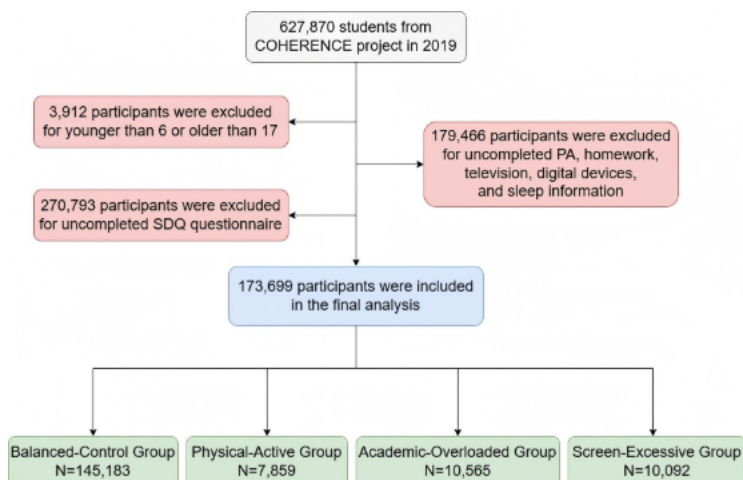


Figure 1

Flow diagram illustrating participant selection

Abbreviations: COHERENCE: the Children's Growth Environment, Lifestyle, and Physical and Mental Health Development Project; PA: physical activity; SDQ: Strengths and Difficulties Questionnaire.

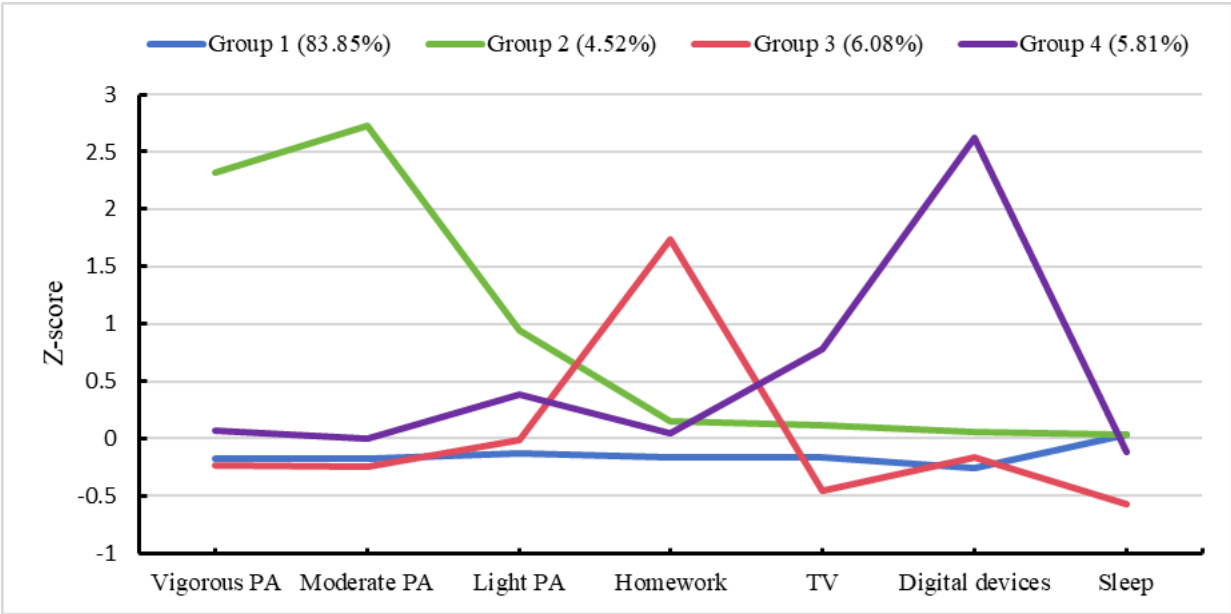


Figure 2

Feature distributions across the four-class latent profile model

Notes: Group 1: Balanced-Control Group; Group 2: Physical-Active Group; Group 3: Academic-Overloaded Group; Group 4: Screen-Excessive Group.

Abbreviations: PA: physical activity; TV: television.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Supplementalmaterials.docx](#)