Preplanned Studies

A Latent Class Analysis of Lifestyle Patterns in Relation to Depressive Symptoms Among Adolescents — Jiangsu Province, China, 2022

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Summary

What is already known about this topic?

Interventions aimed at modifying lifestyle behaviors can effectively reduce the risk of depression among adolescents. These lifestyle behaviors tend to be interconnected; thus, changes to one behavior can often lead to changes in others, usually occurring simultaneously.

What is added by this report?

Adolescents from Jiangsu Province displayed distinct lifestyle patterns, with those engaging in multiple specific behaviors, such as excessive consumption of sugar-sweetened beverages and prolonged screen time, showing increased odds of depression.

What are the implications for public health practice?

Early implementation of anti-depression interventions in adolescents should be advocated and prioritized, particularly targeting multiple high-risk lifestyles.

Depressive symptoms are a major contributor to global disability and are notably linked to increased rates of suicide among adolescents. While previous studies have assessed the impact of individual lifestyle behaviors on depressive symptoms, the simultaneous influence of multiple behaviors remains unclear, leaving their collective impact ambiguous. This study aimed to delineate lifestyle patterns in adolescents and explore their relationship with depressive symptoms using data from a 2022 project implemented in Jiangsu Province, China. The study involved 33,749 junior high school students and employed latent class analysis to identify lifestyle patterns and logistic regression to examine their association with depressive symptoms. The evaluated behaviors included dietary habits, pet ownership, physical activity, electronic media usage, sleep quality, and experiences of being bullied. We identified four distinct lifestyle patterns: "adolescents displaying no discernible targeted behaviors" (6,545 students), "dog owners who consume sugar-sweetened beverages (SSB) and use electronic media" (18,792 students), "cat owners who consume SSB and use electronic media" (4,726 students), and "adolescents exhibiting multiple targeted risk behaviors" (3,686 students). Compared to adolescents displaying no discernible targeted behaviors, those in the "cat owners who consume SSB and use electronic media" group had a significantly higher association with depressive symptoms [odds ratio (*OR*)=1.59, 95% confidence interval (*CI*): 1.44, 1.75], as did adolescents with multiple targeted risk behaviors (*OR*=6.58, 95% *CI*: 5.98, 7.23). These findings underscore the variability in depressive symptoms across adolescents with different lifestyle patterns, highlighting the importance of targeting at-risk groups in early intervention strategies for depression prevention and control.

From September 2022 to November 2022, we conducted an extensive population-based, cross-sectional study in Jiangsu Province within the scope of the "Surveillance for Common Disease and Health Risk Factors among Students" project, detailed previously (*1*). A total of 33,749 junior high school students participated in the study. All participants received full information on the study's objectives, procedures, potential benefits, and risks. Informed consent was obtained prior to their completion of the self-reported questionnaires. The Ethics Commission approved this study (No. 2023ZDSYLL456-P01).

Depressive symptoms were evaluated using the Center for Epidemiological Studies-Depression (CES-D) Scale, comprising 20 items. Participants rated the presence and severity of their symptoms over the previous week using a four-point Likert scale. Scores range from 0 to 60, where higher scores indicate more severe depressive symptoms. A threshold of 16 was established to differentiate participants with and without depressive symptoms.

We evaluated participants based on various lifestyle factors, including smoking, alcohol consumption, SSB intake, ownership of cats or dogs, insufficient exercise, television viewing, computer use, and mobile electronic media usage. Additionally, we examined lifestyle elements such as inadequate sleep and experiences of being bullied, treating all these factors as binary variables.

We incorporated both demographic and health-related variables in our logistic regression analysis (*2*). Demographic factors included gender (female/male), age group (11–13/14–17 years), maternal education level (primary school or illiteracy/high school/college and above), residential location (rural/urban), and family structure (core family/non-core family). The health-related variables consisted of the presence of physical illness and being overweight or obese, each defined as binary outcomes (yes/no). Physical illnesses were assessed by determining whether participants reported conditions such as hepatitis, nephritis, heart disease, hypertension, anemia, diabetes mellitus, allergic asthma, or other physical disabilities. Those affirming any condition were classified as having a physical illness, whereas those denying any were placed in the non-illness group.

We utilized R Statistical Software (version 4.3.3, R Development Core Team, Vienna, Austria) for statistical analysis, exploring potential lifestyle patterns among participants and examining the link between these patterns and depressive symptoms. Latent class analysis helped identify distinct lifestyle groups. Model selection was based on comparing n-class with (n-1)-class models, starting from two classes. Preference was given to models with lower values of Akaike information criterion (AIC), Bayesian information criterion (BIC), and sample-size-adjusted BIC (aBIC), coupled with no significant improvement as indicated by the Lo-Mendell-Rubin likelihood ratio test (LMR-LRT) and bootstrap likelihood ratio test (BLRT), together with relatively higher entropy. Logistic regression analysis was conducted to assess the relationship between identified lifestyle classes and depressive symptoms (*2*). A *P* value below 0.05 was considered statistically significant.

A total of 33,749 students participated in the survey, with an average age of 13.28±0.94 years. Of these, 46.72% (*n*=15,766) were female. Approximately one-fifth (21.23%) of the students exhibited depressive symptoms (Table 1).

TABLE 1. Characteristics of the participants.

Variables	Depressive symptoms	
	No	Yes
	N=26,585 (%)	*N*=7,164 (%)
Age group (years)		
11–13	15,610 (58.72)	3,618 (50.50)
14–17	10,975 (41.28)	3,546 (49.50)
Gender		
Female	11,824 (44.48)	3,942 (55.03)
Male	14,761 (55.52)	3,222 (44.97)
Residential location		
Rural	13,698 (51.53)	3,597 (50.21)
Urban	12,887 (48.47)	3,567 (49.79)
Family structure		
Core family	12,701 (47.78)	2,995 (41.81)
Non-core family	13,884 (52.22)	4,169 (58.19)
Paternal education		
Primary school or illiteracy	1,756 (6.61)	590 (8.24)
Middle or high school	19,811 (74.52)	5,450 (76.07)
College and above	5,018 (18.88)	1,124 (15.69)
Maternal education		
Paternal education	3,437 (12.93)	1,158 (16.16)
Primary school or illiteracy	18,860 (70.94)	5,032 (70.24)
Middle or high school	4,288 (16.13)	974 (13.60)
Physical illness		
No	26,385 (99.25)	7,063 (98.59)
Yes	200 (0.75)	101 (1.41)
Overweight/obesity		
No	16,604 (62.46)	4,506 (62.90)
Yes	9,981 (37.54)	2,658 (37.10)

Model fit indicators for 1 through 5 class solutions are summarized. The AIC, BIC, and adjusted BIC all favored a 5-class solution. However, though the 5-class solution provided greater entropy than the 4-class solution, the distribution of the total sample across the classes was more balanced in the 4-class model. Additionally, the subjective interpretation of the 4- and 5-class solutions was similar, but the 4-class solution was simpler. Therefore, we selected the 4-class solution for further analysis. This solution defines four mutually exclusive and collectively exhaustive groups, assigning individuals to one class based on the highest probability of membership (Supplementary Table S1, available at https://weekly.chinacdc.cn/).

We identified four distinct lifestyle patterns among the participants: "adolescents displaying no discernible targeted behaviors" (6,545 individuals), "dog owners who consume SSB and use electronic media" (18,792

individuals), "cat owners who consume SSB and use electronic media" (4,726 individuals), and "adolescents exhibiting multiple targeted risk behaviors" (3,686 individuals).

Figure 1 illustrates the conditional probabilities for all behavioral variables across four latent classes. Class 1, representing approximately one-fifth of the study population (*N*=6,545, 19.39%), consisted of adolescents displaying no discernible targeted behaviors, indicating an absence of the specified behaviors. Class 2 comprised 18,792 students (55.68% of the total), characterized by significant SSB intake, dog ownership, and frequent engagement in electronic media use. In comparison, Class 3 included 4,726 students (14.01%), primarily cat owners who also engaged in SSB intake and electronic media use. Class 4, the smallest subgroup with 3,686 students (10.92%), consisted of "adolescents exhibiting multiple targeted risk behaviors", including smoking, alcohol consumption, insufficient exercise, typical electronic device usage, poor sleep quality, and experiences of being bullied. Inadequate exercise was a common element across all identified classes.

Compared to "adolescents displaying no discernible targeted behaviors," the risk of depressive symptoms was higher in "cat owners who consume SSB and use electronic media" (*OR*=1.59, 95% *CI*: 1.44, 1.75) and in "adolescents exhibiting multiple targeted risk behaviors" (*OR*=6.58, 95% *CI*: 5.98, 7.23) (Table 2).

DISCUSSION

The prevalence of depressive symptoms among adolescents in Jiangsu Province stands at 21.23%,

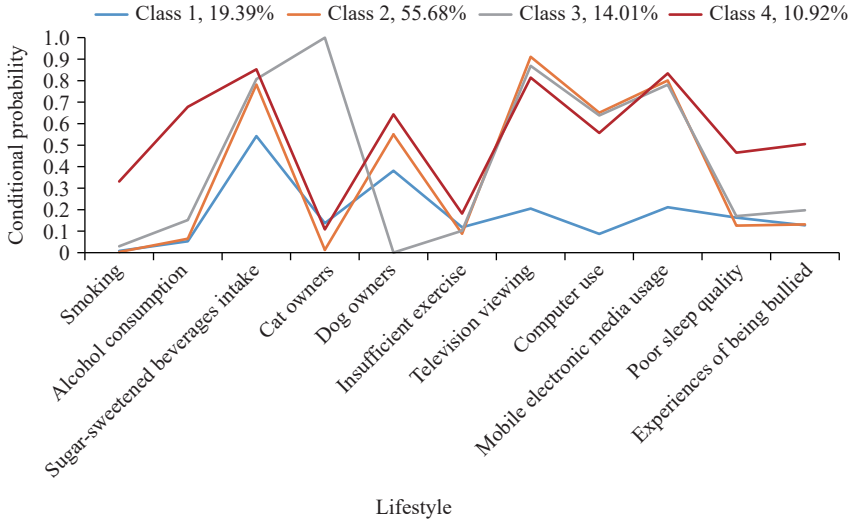

FIGURE 1. Conditional probability of each behavioral lifestyle indicator across four latent classes.
Note: Class 1: Adolescents displaying no discernible targeted behaviors; Class 2: Dog owners who consume SSB and use electronic media; Class 3: Cat owners who consume SSB and use electronic media; Class 4: Adolescents exhibiting multiple targeted risk behaviors.
Abbreviation: SSB=sugar-sweetened beverages.

TABLE 2. Association between latent classes of lifestyle patterns and depressive symptoms in adolescents (*N*=33,749).

Latent classes	Model 1* *OR* (95% *CI*)	Model 2† *OR* (95% *CI*)
Class 1: Adolescents displaying no discernible targeted behaviors	1.00	1.00
Class 2: Dog owners who consume SSB and use electronic media	1.05 (0.97, 1.13)	1.04 (0.96, 1.12)
Class 3: Cat owners who consume SSB and use electronic media	1.63 (1.49, 1.80)§	1.59 (1.44, 1.75)§
Class 4: Adolescents exhibiting multiple targeted risk behaviors	6.48 (5.91, 7.11)§	6.58 (5.98, 7.23)§

Abbreviation: *OR*=odds ratio; *CI*=confidence intervals.
* Model 1 was adjusted for no covariates.
† Model 2 was adjusted for covariates including age group, gender, location, family structure, paternal education, maternal education, physical illness, and overweight/obesity.
§ *P*<0.001.

which exceeds the reported 17.80% in Tianjin (*3*) but remains below the 25.60% observed in northeastern cities within the province (*4*). This delineates the critical need for preventive strategies targeting psychological health concerns in middle school students. In our study of 33,749 school-aged adolescents, we identified four distinct behavioral patterns: "adolescents displaying no discernible targeted behaviors," "dog owners who consume SSB and use electronic media," "cat owners who consume SSB and use electronic media" and "adolescents exhibiting multiple targeted risk behaviors." This variety in lifestyle behaviors might affect the success of anti-depression initiatives. By recognizing these unique patterns, we can better target subgroups most likely to benefit from customized behavioral interventions. Our findings indicate varied probabilities of depressive symptoms across these lifestyle groups, underscoring the need for tailored anti-depression strategies that effectively address specific behaviors and practical needs. Implementing comprehensive behavioral interventions, such as sustainable school-based programs promoting sleep (*5*) and preventing bullying (*6*), could mitigate depressive symptoms among adolescents.

Previous studies employing latent class analysis have categorized the behavioral lifestyles of children and adolescents into four distinct groups, aligning with our results concerning smoking, alcohol consumption, and electronic device usage (*7*). However, the distribution and characteristics of adverse behaviors varied across these groups, leading to different class proportions and naming conventions. For instance, an Australian study examined six behaviors (lack of physical activity, sugary drink consumption, alcohol consumption, smoking, poor sleep, and excessive screen time) in a cohort of 6,640 adolescents aged 11–14, identifying three latent classes: relatively low risk (30%), moderate risk (67%), and high risk (3%). Such disparities likely stem from differences in study populations and the specific behaviors included in the analyses (*8*).

Compared to "adolescents displaying no discernible targeted behaviors," groups identified as "cat owners who consume SSB and use electronic media" and "adolescents exhibiting multiple targeted risk behaviors" demonstrated associations with depressive symptoms. The defining characteristic of the "cat owners who consume SSB and use electronic media" group is cat ownership, which some studies suggest may be associated with an increased risk of depressive symptoms. Factors such as smoking, alcohol consumption, cat ownership, electronic media usage, poor sleep quality, and experiences of being bullied have all been linked to a heightened risk of depressive symptoms (*9*). Given the prevalence of "adolescents exhibiting multiple targeted risk behaviors" within the study population, prioritizing interventions for sleep disturbances and bullying is imperative. Developing strong family and school support systems is essential to mitigate depressive symptoms in adolescents.

This study is subject to some limitations. First, the cross-sectional design limits our ability to establish a causal relationship between lifestyle patterns and depressive symptoms. Thus, the results should be interpreted cautiously. Future longitudinal studies are needed to more accurately quantify the impact of various lifestyles on the development of depressive symptoms. Second, the study was conducted in Jiangsu Province, one of China's most affluent areas. The perceptions of unhealthy lifestyles in this population may differ from those in less affluent regions (*10*). Third, the categorization of targeted lifestyles may lead to both loss of information and potential misclassification bias, warranting a cautious interpretation of the findings. Effective intervention strategies require a detailed understanding of the complex nature of depressive symptoms. Our findings highlight the necessity of addressing the relationship between lifestyle and depression when developing cognitive and behavioral programs aimed at improving the mental health of adolescents. Continued efforts are essential to prioritize tailored interventions for adolescents with at-risk lifestyles.

Conflicts of interest: No conflicts of interest.

Acknowledgements: All study participants.

Funding: Support from the National Social Science Foundation of China (Grant no. 23CGL072), the Ministry of Science and Technology (Grant no. G2023141005L), the Ministry of Education (Grant no. 1125000172), and the Jiangsu Provincial Department of Science and Technology.

doi: 10.46234/ccdcw2024.213

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Submitted: March 18, 2024; Accepted: May 21, 2024

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SUPPLEMENTARY MATERIAL

SUPPLEMENTARY TABLE S1. Model fit statistics for latent class analysis of behavioral lifestyle patterns among adolescents in Jiangsu.

Model	AIC	BIC	aBIC	LMR-LRT *P*	BLRT *P*	Entropy	Class probability
1	375,110.98	375,110.97	375,168.71	−	−	1.00	1.00
2	364,981.23	365,175.05	365,101.95	<0.001	<0.001	0.68	0.75/0.25
3	359,597.18	359,892.12	359,780.89	<0.001	<0.001	0.65	0.14/0.22/0.64
4	355,148.91	355,544.97	355,395.60	<0.001	<0.001	0.75	0.11/0.55/0.14/0.20
5	354,335.62	354,832.79	354,645.29	<0.001	<0.001	0.77	0.36/0.04/0.31/0.10/0.19

Note: "−" indicates that this test was not performed on that model.

Abbreviation: AIC=Akaike information criterion; BIC=Bayesian information criterion; aBIC=Sample-size-adjusted Bayesian information criterion; LMR-LRT=Lo-Mendell-Rubin likelihood ratio test; BLRT=bootstrap likelihood ratio test.