Relationship between physical activity, screen-related sedentary behaviors and anxiety among adolescents in less developed areas of China

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Abstract

This study aimed to explore the association between physical activity, screen-related sedentary behaviors, and anxiety. The current study used latent profile analysis (LPA) to identify homogenous subtypes of anxiety among adolescents in less-developed areas of China. Data were aggregated from 6 schools in the less-developed areas of China in September 2018. In total, 900 students were evaluated using the 100-item Mental Health Test (MHT) and Youth Risk Behavior Surveillance System (YRBSS) questionnaire. The LPA was conducted to explore the potential classification of anxiety, which makes full use of all the sample data and explore heterogeneous classifications within groups. Logistic regression was used for the multifactor analysis. A P value <.05 was considered statistically significant. The entropy value suggested that the model with 3 latent profile was the best choice. There were 223 adolescents in the severe anxiety group, accounting for 24.78%. Logistics regression analysis of anxiety revealed that the risk of severe anxiety in boys was lower (odds ratio [OR] = 0.317, P < .001) than in girls. Students had a significantly lower probability of suffering from severe anxiety in using cellphones or computers ≤ 2 hours/day than those used cellphones or computers＞2 hours/day (OR = 0.391, P = .004). Decreasing screen-related sedentary behaviors should be a target of community and school-based interventions, because high screen-related sedentary behaviors were associated with higher odds of anxiety among adolescents in less developed area of China.

Abbreviations: AIC = Akaike information criterion, BIC = Bayesian information criteria, LPA = latent profile analysis, MHT = mental health test, OR = odds ratio, YRBSS = youth risk behavior surveillance system.

Keywords: adolescents, anxiety, latent profile analysis (LPA), mental health, physical activities, sedentary behaviors

1. Introduction

Currently, the anxiety of adolescents is becoming a serious public health concern, and further attention from families, schools, and society are needed. Anxiety is the painful feeling that we typically recognize as uneasiness, apprehension, or worry.[1] Anxiety is excessive and persistent worry which affected on one's ability to carry out activities of daily living. In recent years, anxiety is high incidence among adolescents.[2–4] Evidence suggests that high levels of anxiety are unusually prevalent among students in China.[5,6] Other studies also found that Chinese adolescents were more anxious than adolescents in other countries.[7,8] Mild anxiety can drive adolescents to adapt to the environment, but severe anxiety may seriously affect physical and mental health.[9]

Understanding the influencing factors of anxiety among junior high school students can guide them to actively prevent and cope with anxiety. Some studies analyzed the correlation between anxiety and gender. A previous research investigated the anxiety of Chinese secondary school students found that girls had more anxiety symptoms than boys.[10] A systematic review also found that females are at higher risk for anxiety.[11] The survey which explored the correlation between anxiety and family status showed that females with incomplete family structure are more likely to develop anxiety.[12] Health lifestyle was an important role in improving their mental health. There

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are also many studies analyzing the correlation between anxiety and lifestyle, such as physical activity, sedentary behaviors.

All over the world, 81.0% of adolescents are lacking in physical activity.[13] Low physical activity and high screen-related sedentary time has become a widely question among adolescents.[14] Physical activity and screen-related sedentary behaviors are generally accepted as being associated with energy expenditure, body weight, and metabolic factors.[15] An annual longitudinal survey at up to 5 time points found that lifestyle was significantly associated with anxiety in adolescents.[16] The result of a study in in Hong Kong suggested that lifestyle is significantly associated with anxiety.[17] Several randomized controlled trials revealed that applied lifestyle changes include physical activity and healthy diet can reduce anxiety levels in patients.[18,19] A cross-sectional survey of 1576 adolescents in China found that a sizeable portion of adolescents were severe anxiety which interfered their life (48% of sample adolescents) and affected their sleep (27% of sample adolescents).[20]

Adolescence is a critical period because mental patterns and behavioral patterns established will affect their present and future physical and mental health.[21] Some researches indicated a negative correlation between physical activity and anxiety may exist.[22] A cross-sectional, community-based survey carried out in 70 countries shown that there was a significant positive correlation between low physical activity and anxiety at the individual country level.[23] Screen-related sedentary behaviors include behaviors such as playing video games, watching television, and using electronic devices (e.g., cellphones or computers). Time spent in screen-related sedentary behaviors has emerged as a potentially important indicator of health. The previous studies suggested screen-related sedentary behaviors potentially cause increasing risks of developing anxiety.[24,25] A systematic review and meta-analysis revealed that higher levels of symptoms of anxiety were associated with higher levels of sedentary behaviors.[26] Evidence from a population-based sample of Canadian adolescents shown that both physical inactivity and sedentary activity appear to be significantly related to symptoms of depression and anxiety.[22] A prospective cohort study in the UK Biobank revealed that individuals in the lowest group for both cardiorespiratory fitness and grip strength had higher odds of anxiety.[27] Anxiety is associated with insufficient physical activity and prolonged screen-related sedentary behaviors.[28]

Despite rich literature, there is still a need to examine this issue in the context of developing countries since many of the results are from developed country research environments, and mental health outcomes may vary greatly by cultures and contexts.[29] Previous studies have shown that anxiety rates are higher among rural students than urban students.[20,30] Adolescents in less developed areas require more attention. The knowledge gained through this study may facilitate the development of physical fitness and mental health promotion policies and programs for adolescents who was located less developed areas Chinese. This project conducted a survey on junior high school students in Jiangxi rural areas which was less developed areas.[31] This study made full use of all the sample data collected from adolescents in the less developed area, explore heterogeneous classifications within groups by using LPA. First of all, the current study used LPA to identify homogenous subtypes of anxiety among adolescents in less developed area of China. Secondly, the study explored age, gender, family structure differences among different anxiety types. Finally, we explored the associations between physical activity, screen-related sedentary behaviors and anxiety.

2. Material and Methods

2.1. Research targets and sampling methods

Jiangxi Province is a less developed region located in middle China. This study investigated junior high school students who came from Yudu County, Shangrao County, Duchang County, Fengcheng County, Dongxiang District, and Suichuan County of Jiangxi Province during September 2018, which was the first semester of 2018 to 2019 academic year. The sample counties determined a sample township. A public central middle school in town was selected as the sampled junior high school. In each sample school, we enrolled students from seventh and ninth grade into our sample. The detailed sampling process is shown in Figure 1.

2.2. Procedure

We conducted questionnaires survey in sample schools. Initially, the researchers interviewed the management team of the selected schools in order to explain the purpose of the study. Then, the parents were provided consent at parents meeting. The investigators, with the assistance of the class teachers, organized all students in sample classes to participate in the research. The survey was administered and proctored by our investigators in the classroom. The junior high school students were informed that the survey was anonymous and voluntary. They completed the survey truthfully and independently, without discussion or interaction. Identification numbers were assigned on the response sheets of each participant. The investigators were physically presenting during the administration of the survey to clarify any potential doubts from students and to verify the correct completion of the questionnaires immediately after students finished. As a result, we ensured the anonymity of the participants and the confidentiality of the data.

2.3. Content of questionnaires

In each of the sample schools, our enumeration teams conducted a 2-part survey.

First part of the survey collected data on the basic demographic characteristic information and health risk behaviors of each student, including gender, age, grade, family structure, physical activity, screen-related sedentary behaviors, whether the student was the only child in family, and whether the student was a left-behind child. The questionnaire in this part of survey referenced to the Youth Risk Behavior Surveillance System (YRBSS) questionnaire.[32–34] YRBSS items assessing physical activities and screen-related sedentary behaviors have previously demonstrated adequately.

Second part of the survey was using mental health test (MHT). The General Anxiety Test was adapted to establish the Chinese version of this questionnaire which was named MHT in the year of 1991.[35–37] And this questionnaire was a standardized anxiety diagnostic scale for elementary school and junior high school students which had been widely applied in China.[38] MHT is a self-assessment scale which is easy to operate and for subjects to accept and master. MHT contains 100 questions, and each of them has 2 answers (Yes = 1 and No = 0). Among the 100 questions, there are 10 questions which are used to detect whether the student is answering honestly. It is called reliability scale. If the score of reliability scale is over 7, the student is considered purposely mis-answering questions in order to higher score. If the score of reliability scale is over 7, the test is considered invalid and will not be used in the analysis of this survey. The remaining 90 questions comprise 8 content scales and make up the students' MHT score.[39] The 8 content scales of MHT measures anxiety from 2 aspects: anxiety objects and anxiety behaviors. Anxiety objects are learning anxiety which represents the school performance of students and interpersonal anxiety which represents the social relationships of students. Anxiety behaviors include lonely tendency, remorse tendency, allergic tendency, physical symptoms, terror tendency, and impulsive tendency.[39] This test has good reliability and validity indicators. The test has a reliability of 0.84 to 0.88 and a retest reliability of
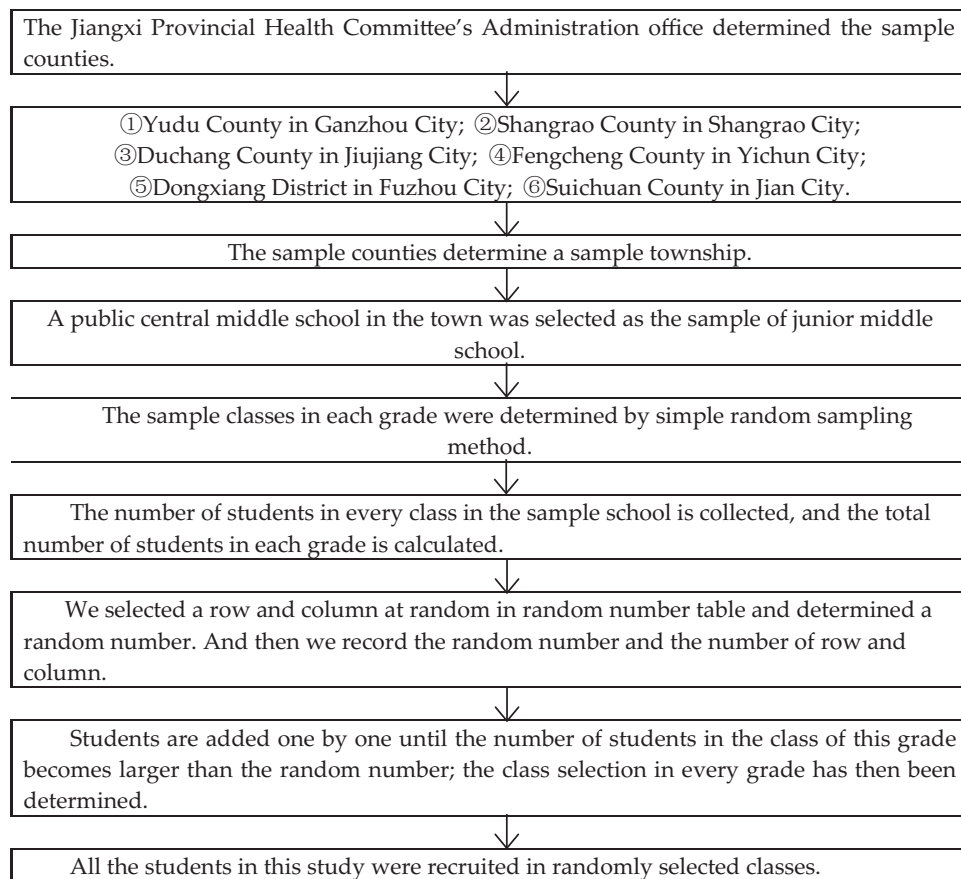
Figure 1. The sampling process.

0.78 to 0.86.[38] This high retest reliability shows that the MHT measures an aspect of mental health that is stable over time.[39] After analysis, the internal consistency reliability as indicated by Cronbach's α coefficient is 0.878. Confirmatory factor analysis shows that the reliability coefficients of the 8 content scales are high. The reliability coefficients of the 8 content scales are learning anxiety (0.847), interpersonal anxiety (0.757), lonely tendency (0.789), remorse tendency (0.777), allergic tendency (0.770), physical symptoms (0.794), terror tendency (0.840), and impulsive tendency (0.839).

2.4. Index definition

2.4.1. Physical activity. Physical activity was measured based on the question "During the past 7 days, how many days did you do physical activity for a total of at least 60 minutes per day? (Add up all the time you spent in any kind of physical activity that increased your heart rate and made you breathe hard some of the time, such as running, playing basketball, playing football, or swimming, and so on.)" Eight response options were available ranging from "0" to "7" days.[40] The responses were categorized into 4 groups: 0 day/week, ≥1 to ≤2 days/week, ≥3 to ≤4 days/week and ≥5 days/week.

2.4.2. Screen-related sedentary behaviors. Screen-related sedentary behaviors covered watching television, using electronic devices. Watching television was assessed by asking students: "During the past 30 days, how many hours do you watch TV everyday on an average?" The answers for this question were divided into "≤2 hours/day" and ">2 hours/day." Using electronic devices was assessed by asking students: "During the past 7 days, how many hours do you use electronic

devices for something that is not for school work? (Count time spent on activities such chatting via instant messaging apps, browsing social networking apps, video games, or streaming on the Internet.)" The answers for this question were divided into "≤2 hours/day" and ">2 hours/day."[40,41]

2.4.3. Potential confounding variables. Potential confounding variables included age (12 years old, 13 years old, 14 years old, 15 years old, 16 years old); gender (boys, girls); family structure (2-parent family, single-parent family or reorganized family); the only child in one's family (yes or no); left-behind children (yes or no). The 1-child policy was a birth planning policy in China to control the rapid population growth during the mid-20th century.[42] In other words, each family was only allowed to have 1 child. Left-behind children are defined as those children under 16 years old who are left at home when both parents migrate to an urban area for work more than 6 months per year, or when one of them migrates to an urban area for work for more than 6 months per year and the other does not have the ability to bring up and supervise the children.[43,44]

2.5. Data analytic approach

Epidata 3.1 (The EpiData Association, Odense, Denmark) was employed to input data. The database was imported into Excel spreadsheets (Microsoft Office 2003, Microsoft, Redmond, DC) and transferred to SPSS 24.0 statistical software (IBM Corporation, Armonk, NY) for basic analysis. The latent profile approach (LPA) was conducted in *Mplus* 7.4 (Linda Muthén & Bengt Muthén) in order to explore the potential classification of anxiety among junior high school students. The differences between variables were compared using the χ^2 statistic method. Logistic regression was used in multifactor analysis. The test

standard as α = 0.05 was considered to be statistically significant for all analyses.

LPA is an advanced statistical technique which has been used in psychology increasingly.[45–47] In LPA, a person-centered categorical latent variable is derived whereby individuals are assigned to 1 profile based on their responses to observed variables.[47,48] LPA uses latent continuous variables to explain the relationship between explicit continuous variables, which makes full use of all the sample data and explore heterogeneous classifications within groups. LPA identify typologies of individuals by examining configurations of traits within those individuals.[46]

LPA was used to detect homogeneous groups using 8 factors of the anxiety, including learning anxiety, interpersonal anxiety, lonely tendency, remorse tendency, allergic tendency, physical symptoms, terror tendency, and impulsive tendency. We compared models with 2-, 3-, 4-, and 5-category solutions to determine the optimal substantive and statistical fit. Model comparisons were made using Bayesian Information Criteria (BIC) and the Akaike Information Criterion (AIC), with lower values indicating the optimal number of latent classes that should be extracted from the variables.[49–51] We also examined the entropy value, with value closer to 1 indicating better classification precision. Entropy values range from 0 to 1.[52–54]When the entropy value is equal to 0.8, the classification accuracy of the model is more than 90%. Lo–Mendell–Rubin likelihood ratio test and Vuong–Lo–Mendell–Rubin likelihood ratio test were examined. Each test assesses the statistical significance of the improvement in the model when an additional class is extracted.[55] Furthermore, the most parsimonious model should be selected, and the smallest class of any class-solution should not contain less than 5% of the sample. After the number and nature of the profiles were identified, individuals were assigned to their most likely profile based on their posterior probabilities.[56]

In this study, survey data were collected from questionnaires that students completed in class. The data were analyzed to detect anxiety homogeneous groups among junior high school students by latent class analysis and explore the association between latent classes of anxiety and physical activity, screen-related sedentary behaviors. By using a multinomial logistic regression, we assessed the association between latent classes of anxiety and physical activity, screen-related sedentary behaviors. These associations were evaluated using odds ratios (ORs), with confidence intervals.

3. Results

3.1. Participants descriptions and latent profile analysis (LPA)

LPA was conducted on the entire sample. The study sample included 965 students from 6 junior high school in Jiangxi Province, and 65 (6.74%) were exempted due to omissions in their responses or because the score of MHT reliability scale was greater than 7, where the score would indicate as invalid samples. The final sample consisted of 900 junior high school

students, aged from 12 to 16, with 467 males (51.89%) and 433 females (48.11%). The average age of the sample students was 14.14 ± 1.32. The distribution of age was as follows: 126(14.00%) students were 12 years old, 157(17.44%) students were 13 years old, 258(28.67%) students were 14 years old, 179(19.89%) students were 15 years old, 180(20.00%) students were 16 years old. The sample's distribution based on academic year was as follows: 289 students were in 7th grade (32.11%), 303 students were in 8th grade (33.67%), 308 students were in 9th grade (34.22%).

Table 1 reports commonly used fit statistics for 1 through 5 class solutions for analytic samples. The entropy value is higher when the model changes from 2 to 3 latent classes. In other words, the entropy value confirms the supremacy of the 3-class solution over alternative solutions. There were significant values ($P < .001$) for Lo–Mendell–Rubin likelihood ratio test and Vuong–Lo–Mendell–Rubin, which suggest that the model with 3 latent classes was the better choice. In addition, the smallest class of every model does not contain samples of less than 5%.

As shown in Figure 2, the lower value of the model information indicators, including AIC, BIC, and adjusted Bayesian information criterion, the better the latent profile solution with increasing numbers of latent classes. The 3-class solution is considered the best-fitting model, where AIC, BIC, and adjusted Bayesian information criterion appears obvious inflection point.

The junior high school students were divided into 3 subgroups by LPA. Group 1 was characterized by the lowest mean scores on all 8 factors of the anxiety and was labeled the "mild anxiety" group. The 8 factors of anxiety included learning anxiety, interpersonal anxiety, lonely tendency, remorse tendency, allergic tendency, physical symptoms, terror tendency, and impulsive tendency. Group 2 was characterized by moderate scores on all 8 factors of the anxiety. This class was labeled the "moderate anxiety" group. Group 3 was characterized by the highest mean scores on all 8 factors of the anxiety. This class was labeled the "severe anxiety" group. Figure 3 shows the means score of 8 facets of anxiety among 3 latent classes of subjects.

3.2. The univariate analysis of anxiety of subjects

Mild anxiety was the smallest group, which had 173 subjects, accounting for 19.22%. As shown as Table 2, moderate anxiety was the largest group, which had 504 subjects, accounting for 56.00%. Severe anxiety had 223 subjects, accounting for 24.78%.

Chi-square (χ^2) tests of the association between demographics and anxiety revealed that girls were significantly more likely than boys to report severe anxiety ($\chi^2 = 31.337$, $P < .001$). There were no statistical differences in age, family structure, whether the student was the only child in family, or whether the student was left-behind children. The number of days of physical activity during the past 7 days was different, there were statistical differences among different subgroups ($\chi^2 = 22.936$, $P = .001$). Comparing students who were using electronic devices >2 hours/day with those who were using electronic deveices ≤ 2

Table 1

Fit estimates multigroup latent profile models for anxiety of subjects by entropy, LMRT, and VLMR.

The number of profiles	Entropy	LMRT	LMRT$_P$	VLMR	VLMR$_P$	Proportions
1	—	—	—	—	—	1
2	0.802	1554.509	<0.001	-16835.516	<0.001	0.547/0.453
3	0.816	577.423	<0.001	-16045.566	<0.001	0.192/0.560/0.248
4	0.773	156.038	0.049	-15752.138	0.047	0.340/0.406/0.073/0.181
5	0.749	107.383	0.187	-15672.845	0.183	0.071/0.340/0.252/0.253/0.083

AIC = Akaike information criterion, BIC = Bayesian information criterion, LMRTP = the *P* value of the Lo–Mendell–Rubin likelihood ratio test, VLMRP = The *P* value of the Vuong–Lo–Mendell–Rubin likelihood ratio test.

Figure 2. Fit estimates multigroup latent profile models for anxiety of subjects by AIC, BIC, ABIC. ABIC = adjusted Bayesian information criterion, AIC = Akaike information criterion, BIC = Bayesian information criterion.
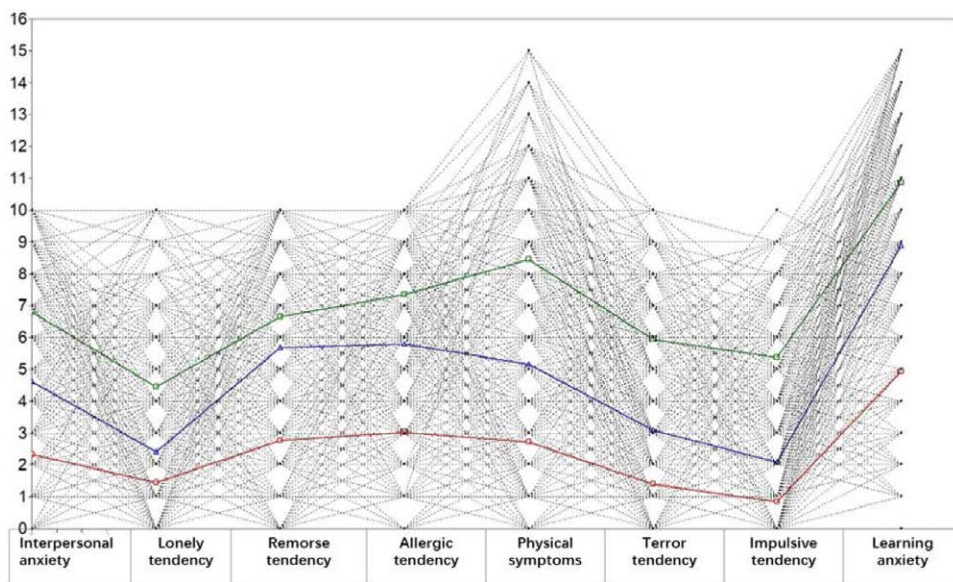
Figure 3. The means score of 8 facets of anxiety among 3 latent classes of subjects.

hours/day, there were statistical significances among different subgroups ($\chi^2 = 10.035$, $P = .007$) (Table 2).

3.3. The multivariate logistic regression of anxiety of subjects

The multivariate logistic regression that looked into the risk of anxiety revealed several significant results. The variables assignment summary for logistic regression analysis is shown in Table 3. The independent variables were input into the equation for analysis by backward stepwise, and the OR of each independent variable was calculated. Results of the logistic regression model are shown in Table 4, with class 1 (mild anxiety) as the reference group. The logistics regression analysis of anxiety revealed that the risk of severe anxiety in boys was lower (OR = 0.317, $P < .001$) than in girls. Students who were using electronic devices ≤2 hours/day had significantly lower odds of

severe anxiety than those who were using electronic devices >2 hours/day (OR = 0.391, $P = .004$).

3.4. Discussion

This study aimed to examine the association between physical activity, screen-based sedentary behaviors and anxiety. It is important to better understand the relationship between physical activities, screen-based sedentary behaviors and anxiety. And this information may help to inform the development of lifestyle improvement strategies for reducing the risk of anxiety in different population groups.

In this study, LPA was used to detect latent classes of anxiety in sample school students. The entropy value confirms the supremacy of the 3-class solution over alternative solutions in this article. This study revealed that a high prevalence of moderate and severe anxiety among adolescents, which were accounting for

Table 2

Demographic characteristics and anxiety category of the subjects.

Variable	Respondents n(%)	Mild anxiety n(%)	Moderate anxiety n(%)	Severe anxiety n(%)	$\chi2$	P
Gender					31.337	<.001
Male	467 (51.89)	110 (63.58)	275 (54.56)	82 (36.77)		
Female	433 (48.11)	63 (36.42)	229 (45.44)	141 (63.23)		
Age (yr)					5.990	.648
12	126 (14.00)	21 (12.14)	72 (14.29)	33 (14.80)		
13	157 (17.44)	26 (15.03)	93 (18.45)	38 (17.04)		
14	258 (28.67)	55 (31.79)	145 (28.77)	58 (26.01)		
15	179 (19.89)	40 (23.12)	98 (19.44)	41 (18.39)		
16	180 (20.00)	31 (17.92)	96 (19.05)	53 (23.77)		
The only child in family					0.129	.937
Yes	57(6.33)	10(5.78)	33(6.55)	14(6.28)		
No	843(93.67)	163(94.22)	471(93.45)	209(93.72)		
Left-behind children					0.088	.957
Yes	263(29.22)	49(28.32)	148(29.37)	66(29.60)		
No	637(70.78)	124(71.68)	356(70.63)	157(70.40)		
Family structure					4.275	.118
Two-parent family	776(86.22)	156(90.17)	435(86.31)	185(82.96)		
Single-parent family or reorganized family	124(13.78)	17(9.83)	69(13.69)	38(17.04)		
Physical activity (days/past 7 d)					22.936	.001
0	333 (37.00)	65(37.57)	177(35.12)	91(40.81)		
1~	303 (33.67)	55(31.79)	162(32.14)	86(38.57)		
3~	178 (19.78)	29(16.76)	124(24.60)	25(11.21)		
≥5	86 (9.56)	24(13.87)	41(8.13)	21(9.42)		
Watching TV (h)					0.301	.860
≤2	673(74.78)	132(76.30)	374(74.21)	167(74.89)		
>2	227(25.22)	41(23.70)	130(25.79)	56(25.11)		
Using electronic devices (h)					10.035	.007
≤2	792(88.00)	157(90.75)	452(89.68)	183(82.06)		
>2	108(12.00)	16(9.25)	52 (10.32)	40 (17.94)		
Total	900 (100.00)	173 (100.00)	504 (100.00)	223 (100.00)		

Table 3

The variable assignment summary for logistic regression analysis.

Factors	Variable name	Factor assignment
Dependent variables		
Anxiety	Y_1, Y_2	Mild anxiety (reference): $Y_1 = 0, Y_2 = 0$
		Moderate anxiety: $Y_1 = 1, Y_2 = 0$
		Severe anxiety: $Y_1 = 0, Y_2 = 1$
Independent variables		
Gender	X_1	0 = Girls (reference); 1 = Boys
Age (yr)	X_2, X_3, X_4, X_5	12 (reference): $X_2 = 0, X_3 = 0, X_4 = 0, X_5 = 0$
		13: $X_2 = 1, X_3 = 0, X_4 = 0, X_5 = 0$
		14: $X_2 = 0, X_3 = 1, X_4 = 0, X_5 = 0$
		15: $X_2 = 0, X_3 = 0, X_4 = 1, X_5 = 0$
		16: $X_2 = 0, X_3 = 0, X_4 = 0, X_5 = 1$
The only child in family	X_6	0 = No (reference); 1 = Yes
Left-behind children (LBC)	X_7	0 = No (reference); 1 = Yes
Family structure	$X8$	0 = Two-parent family (reference); 1 = Single-parent family or reorganized family
Physical activity (d)	X_9, X_{10}, X_{11}	0 day (reference): $X_9 = 0, X_{10} = 0, X_{11} = 0$
		1~ days: $X_9 = 1, X_{10} = 0, X_{11} = 0$
		3~ days: $X_9 = 0, X_{10} = 1, X_{11} = 0$
		≥5 days: $X_9 = 0, X_{10} = 0, X_{11} = 1$
Watching TV (h)	X_{12}	0=>2 hours(reference): 1=≤2 hours
Using electronic devices (h)	X_{13}	0=>2 hours(reference): 1=≤2 hours

56.00% and 24.78% especially. A study in junior high school students has indicated that severe anxiety accounts for 35%, which is higher than the results of this survey.[57]

A previous study revealed that gender differences in anxiety rates, finding that girls were more anxious than boys.[58] In this study we found a higher prevalence of anxiety among girls. A study which sample had 1012 adolescents also revealed that the rate of severe anxiety in girls was higher than boys.[59] The reason may be that there is gender difference in coping press and with anxiety. The result of our study is consistent with previous studies.[25,60,61] This may be due to girls being more sensitive to their surroundings and events. Therefore, schools should focus on guidance on girls psychological counseling and coping with anxiety for, in order to improve their mental health development.[62] In this study, we did not find statistical significance in whether the student was only child in the family, whether the

The multivariate logistic regression of anxiety of subjects.

Variable	Moderate anxiety		Severe anxiety	
	OR (95%C.I.)	P	OR (95%C.I.)	P
Gender	Female as Ref.		Female as Ref.	
Male	0.703 (0.489,1.011)	.057	0.317 (0.208,0.485)	<.001
Physical activities (d/past 7 d)	0 as Ref.		0 as Ref.	
1~	1.118 (0.734,1.702)	.603	1.272 (0.789,2.050)	.324
3~	1.610 (0.981,2.645)	.060	0.678 (0.360,1.278)	.230
≥5	0.690 (0.384,1.242)	.216	0.893 (0.448,1.782)	.749
Using electronic devices (h/d)	>2 as Ref.		>2 as Ref.	
≤2	0.847 (0.467,1.537)	.585	0.391 (0.207,0.738)	.004

student was a left-behind child, and whether the student was in a single-parent family or a reorganized family. In a cluster sampling method survey with a sample consisting of 5249 students in China, the results revealed that anxiety status were prevalent among students, especially in no-only child, which may have better the family status.[62] It was not consistent with this study.

The physical activity was measured based on the number of days during the past 7 days doing physical activity for 60 minutes or more per day. In this study, 37.00% of the adolescents did not have adequate physical activity during the past 7 days. The percentage was higher than the result of a cross-sectional study which was conducted in 8 middle schools in Jiangsu Province in China.[63] The survey in urban and rural middle schools revealed that about 10% of the adolescents never had vigorous physical activity.[63] In this study, 29.34% of students had physical activity 3 times or more during the past 7 days. As observed 824 adolescents, half of the boys and 40% of the girls had vigorous physical activity 3 times/week or more.[63] We found that statistical significance among different subgroup of physical activity when we used χ^2 statistic method. But the result of multivariate logistic regression did not find that statistical significance between physical activity and anxiety. A population-based survey with a sample consisting of 11,110 adolescents showed that physical activity was negatively correlated with anxiety.[64] That means more frequent physical activity decreased levels of anxiety.[64] Cross-sectional, community-based data from the World Health Survey showed that individuals engaging in low physical activity had 1.32 (95% confidence interval = 1.17–1.47) times higher odds for anxiety than those with high physical activity.[23] These results was not consistent with this study. The reasons may be shared variance between adolescent self-reports of screen-related sedentary behaviors and physical activity may explain our findings. Data from a representative sample of 2320 adolescents aged 12 to 17 years in Ontario also found shared variance between screen-related sedentary behaviors and physical activity.[65] A UK cohort study with 4257 adolescents found that a positive association between device-measured sedentary behavior with anxiety symptoms, independent of total physical activity volume.[66] It found that higher light physical activity was associated with a decrease in anxiety symptoms but moderate-to-vigorous physical activity was not associated with anxiety.[66] The device-measured physical activity may more accurate than self-reports. In other words, shared variance between screen-related sedentary behaviors and physical activity may exist. The displacement hypothesis predicts that the time spent on screen-based sedentary behavior competes with the time participating in physical activity. This may mean that high screen-based sedentary behavior may be related to low physical activity or vice versa. It still recommended that an active lifestyle and encourage participation in daily physical activity, including both light-intensity and moderate to vigorous-intensity physical activities.[67] As a common mental health problem anxiety may form in a little long-term. It was better that using sports bracelets continuously measured physical activity which can reflect the real level of physical activity in adolescents.

A total of 10,214 adolescents from18 schools in 10 cities in China revealed that screen-based sedentary behaviors (television viewing, 43%; computer use, 30.2%) were prevalent.[68] Screen-based sedentary behavior was considered as "invisible" risk behaviors, which were related to adolescent psychological problems.[69] A survey utilized a multistage randomized cluster design drawing from 9 Chinese provinces found that statistically significant trends toward increased computer using (P < .01).[70] In our study, the proportion of adolescent using cell phone or computer >2 hours/day was higher, the degree of anxiety was severer. There were 17.94% of severe anxiety and 10.32% of moderate anxiety students used a cell phone or computer >2 hours/day. There were statistical differences among different subgroups (χ^2 = 10.035, P = .007). In this study, adolescents had significantly lower odds of severe anxiety in using a cell phone or computer ≤ 2 hours/day than those using a cell phone or computer >2 hours/day (OR = 0.391, P = .004). A meta-analysis in 24 low- and middle-income countries demonstrated that sedentary behaviors of >2 hours/day (vs ≤2 hours/day) was associated with an increased risk of anxiety symptoms (OR = 1.22; 95% confidence interval = 1.10–1.37).[25] It was consistent with this study.

A total of 3826 seventh graders were recruited in a study, which indicate that anxiety symptoms may become more severe when social media use, television viewing, and/or computer use increase.[71] Engaging in screen-related sedentary behaviors may lead to high levels of anxiety through biological pathways.[24] But this study did not find that anxiety symptoms become more severe when watching television increase. Watching television may all at same level among different subgroups of anxiety adolescents. We did not find statistical differences among different subgroups. The link between screen-based sedentary behaviors and anxiety may be explained by a social withdrawal theory. This theory posits that engaging in prolonged sedentary behaviors, such as watching television, using eletronic devices may lead to social solitude and increased anxiety.[24]

The current study identified homogenous subtypes of anxiety using LPA that included the 8 anxiety themes. In subgroups of adolescents, prevention and intervention efforts might benefit from specifically targeting learning anxiety and physical symptoms.[72] The knowledge gained through this study may facilitate the development of physical fitness and mental health promotion policies and programs for adolescents who was located less developed areas Chinese.

It should be noted that there were several limitations in the current study. First, the sample was only representative of 6 schools in Jiangxi province. Due the cross-sectional analysis, the present findings could not be supported as a causal link. Furthermore, the self-reported information could be susceptible to recall bias. The overweight/obesity has been associated with higher sedentary behavior and lower physical activity level in adolescents, and with anxiety as well.[73,74] The further study need to collect data on height, weight, physical activity and screen-related sedentary behaviors by professional equipment.

4. Conclusion

This research examined the association between physical activity, screen-based sedentary behavior and anxiety in less developed area of China. High screen-related sedentary behaviors were associated with higher odds of anxiety among adolescents. Findings from the current study help parents and teachers identify adolescents with high level of anxiety. Moreover, this research provides guidance for adolescents having better lifestyles. Decreasing screen-related sedentary behaviors should be a target of community and school-based interventions.

Author contributions

Acknowledgments

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