Addictive Behaviors 163 (2025) 108260

Contents lists available at ScienceDirect

Addictive Behaviors

journal homepage: www.elsevier.com/locate/addictbeh

The association between screen time trajectories and the comorbidity of depression and anxiety

Jie Zhang [a], Xinyi Feng [a], Qin Zhang [a], Di Wu [a,b], Wenhe Wang [a], Shudan Liu [a], Qin Liu [a,*]

[a] Research Center for Medicine and Social Development, School of Public Health, Chongqing Medical University, Chongqing, China
[b] College of Medical Informatics, Chongqing Medical University, Chongqing, China

ARTICLE INFO

Keywords:
Adolescents
Anxiety
Children
Depression
Mental health
Screen time

ABSTRACT

Depression and anxiety are often comorbid among adolescents. Adolescent screen time changes over time. This study investigates the association between screen time trajectories and the comorbidity of depression and anxiety from a longitudinal perspective. The data were collected from an ongoing prospective puberty cohort which was established in 2014 from Chongqing, China. 838 participants (52.03 % female; wave 1 mean age = 8.62, SD = 1.15) were followed up from 2014 to 2020. Questions about screen time were administered every six months. Trajectories of screen time were identified using latent class growth analysis. Children's Depression Inventory (CDI) and Screen for Child Anxiety Related Disorders (SCARED) were used to measure depression and anxiety. Latent profile analysis was used to identify the subtypes of comorbidity of depression and anxiety. Logistic regression was used to explore the association between screen time trajectory and the comorbidity of depression and anxiety. Three distinct trajectories of screen time were identified: Group Low (68.26 %) had consistently low screen time, Group High (26.37 %) had high screen time and Group Increasing (5.37 %) was characterized by an increasing screen time. Four subtypes of the comorbidity of depression and anxiety were fitted ("High comorbidity", "Low comorbidity", "Low depression symptoms" and "No symptoms"). Group Increasing and Group High were associated with "Low comorbidity" and "Low depression symptoms". Group Increasing was more likely to be the "high comorbidity" both boys and girls. However, Group High was associated with "high comorbidity" only in girls. The results of this study may inform future research and provide possible intervention targets.

1. Introduction

Depression and anxiety are significant mental health concerns that affect children and adolescents worldwide (Vos et al., 2020). In China, the prevalence rates of depression and anxiety among this population are approximately 19.85 % and 26 % (Rao et al., 2019) respectively. Moreover, depression and anxiety often co-occur (Kalin, 2020; Sun et al., 2023), with 10–75 % of adolescents with depression experiencing comorbid anxiety disorders (Avenevoli et al., 2001; Cummings et al., 2014), while 10–15 % of adolescents with anxiety disorders also report depression (Axelson & Birmaher, 2001). Furthermore, previous studies have emphasized the importance of considering comorbid anxiety and depression, rather than focusing on each disorder alone, among children and adolescents (Auerbach et al., 2022; Preisig et al., 2001). Adolescents with comorbid anxiety and depression not only face a higher risk of suicide (Wang et al., 2023) but also tend to have poorer treatment outcomes (Maurizio Fava et al., 2008), including longer treatment response times and smaller reductions in symptoms (Altamura et al., 2004), compared to individuals with each disorder alone.

The comorbidity of depression and anxiety presents significant heterogeneity among children and adolescents (Kircanski et al., 2017). Similar diagnoses may exhibit different symptom patterns such as high depression and low anxiety, or low depression and high anxiety (Y. Wang et al., 2021). To identify the heterogeneity, traditional previous studies (Wang et al., 2023) typically used a "variable-centered" approach where they focused on cutoff scores of total score scales while

Abbreviations: AIC, Akaikei Information Criterion; AvePP, The average posterior probability; BIC, Bayesian Information Criterion (BIC); BLRT, Bootstrap Likelihood Ratio Test; CDI, Children's Depression Inventory; LCGM, Latent Class Growth Model; LPA, Latent Profile Analysis; OCC, The Odds of Correct Classification; SD, Standard Deviation; SCARED, Screen for Child Anxiety Related Disorders.

* Corresponding author at: School of Public Health, Research Center for Medicine and Social Development, Chongqing Medical University, No.1 Yixueyuan Road, Yuzhong District, Chongqing 400016, China.
E-mail address: liuqin@cqmu.edu.cn (Q. Liu).

https://doi.org/10.1016/j.addbeh.2025.108260
Received 11 July 2024; Received in revised form 4 January 2025; Accepted 10 January 2025
Available online 11 January 2025

overlooking subthreshold comorbidity (Lahey et al., 2022) and population diversity. However, Latent Profile Analysis (LPA) offers a "person-centered" method that considers these overlooked aspects. LPA utilizes inter-individual variations in different components of variables to uncover hidden population segments based on similar response patterns from continuous observed variables. This data-driven technique probabilistically classifies participants into latent subgroups, where individuals within each subgroup exhibit similar responses but differ from those in other subgroups (Wang & Hanges, 2011). Moreover, recent research (Sun et al., 2023) has confirmed the effectiveness of LPA in identifying the heterogeneity of comorbid depression and anxiety among children and adolescents.

As mobile Internet devices have developed, children's exposure to screen time has gradually increased (Rideout, 2016). Digital technology itself offers benefits; appropriate screen time and high-quality content can help promote students' interest in learning and enrich educational activities. At the same time, methods like text messaging may also enhance social interactions among children and adolescents. However, growing attention is being paid to the negative health consequences of excessive screen time on children (Lissak, 2018). Existing research suggests that excessive screen time is associated with childhood obesity (Fang et al., 2019), sleep disorders (Hale & Guan, 2015), delayed communication development (Takahashi et al., 2023), and mental health (Santos et al., 2023), particularly depression and anxiety.

Numerous studies have examined the relationship between screen time and depression or anxiety, with most of them being cross-sectional studies (Alvarez de Mon et al., 2024; Liu et al., 2024; Montag et al., 2024; Nagata et al., 2024). A worldwide systematic review has found a link between screen time and internalizing behaviors (such as depression and anxiety) in children (Eirich et al., 2022). However, there is a dearth of longitudinal studies examining the associations between screen time and depression or anxiety. On one hand, the few available longitudinal studies have produced inconsistent findings. A systematic review (Tang et al., 2021) revealed that total screen time at baseline was associated with subsequent depression, rather than anxiety. On the other hand, previous studies have assessed screen time based solely on a single measurement, ignoring the potential heterogeneity and changing patterns of screen time in children over time. Identifying longitudinal patterns and heterogeneity in screen time may have clinical benefits, considering that distinct screen time trajectories have been associated with childhood cognitive development (Zhao et al., 2022) and bone mineral content (J. A. McVeigh et al., 2016). Compared to standard growth models which model an average developmental trajectory based on that all individuals change in the same direction and strength over time, LCGM enables identification of distinct subgroups following similar patterns of change over time, thereby improving estimates of screen time changes. Some studies have examined subsequent mental health outcomes associated with identified screen time trajectories using the Latent Class Growth Model (LCGM) (Trinh et al., 2020), but these studies have also produced inconsistent findings. For instance, Zhu et al. (2023) found a singular association between screen time trajectories in adolescence and any one of depression, anxiety, suicidal ideation, or self-harm in adulthood. However, Joanne et al. (2016) reported no relationship between television-watching trajectories from childhood to early adulthood and depression or anxiety.

Moreover, the mechanisms of screen time contribute to depression and anxiety in children and adolescents are complex. Age (Bita et al., 2021) and gender (Forte et al., 2023) may play an important role. The proportion of adolescents with high screen time was higher among the older participants (Delisle Nyström et al., 2023). Cross-sectional studies have suggested that girls exhibited a stronger association between screen time and mental health than boys (Twenge & Farley, 2021). This difference may be due to that girls have higher prevalence (Shorey et al., 2022) and greater symptom severity (Altemus et al., 2014) of depression and anxiety. Additionally, gender differences in screen time usage may exist. Compared to boys, girls tend to report higher overall screen time (Carson & Kuzik, 2017), with a greater proportion of that time spent on social media and online communication platforms (Twenge & Martin, 2020).

Above all, although numerous studies have investigated the relationships between screen time and depression or anxiety, these studies may not consider the comorbidity of depression and anxiety, as well as the changing patterns of screen time. Consequently, there is a need to examine the association between screen time trajectory and the concurrent occurrence of depression and anxiety in children and adolescents. This research is vital as it offers a more profound comprehension of how long-term, habitual screen time usage relates to depression and anxiety, thus enabling the development of more precise preventive measures.

In this longitudinal study, we used self-report questionnaires to assess participants' depressive and anxiety symptoms and then employed two "person-centered" methods (LCGM and LPA) to model the screen time trajectory and depression-anxiety comorbidity. We hypothesized that there are distinct trajectories of screen time development and different subtypes of comorbid depression and anxiety in children and adolescents. It is further hypothesized that increasing screen time trajectory may be associated with high comorbidity of depression and anxiety.

2. Methods

2.1. Population

The data for this study were obtained from an ongoing prospective puberty cohort established in Chongqing, Southwest China. Initially, a total of 1,429 students from grades 1–4 (mean age at Wave 1 = 8.75, SD = 1.22) were recruited, with consent obtained from both parents and children. Starting in 2014, questionnaires and physical examinations were conducted every six months. Details of the cohort methodology have been reported previously (Liu et al., 2017). For the present study, data from Wave 1 to Wave 12 were analyzed. From the original 1,429 students in Wave 1, only participants who had a minimum of three screen time measurements from Wave 1 to Wave 11 were included (25 students had less than three screen time measurements). In addition, participants who completed depression and anxiety scales in Wave 12 were included (566 students were lost to follow-up in Wave 12). Overall, a total of 838 (52.03 % female; wave 1 mean age = 8.62, SD = 1.15) participants were included in the final analysis. It is important to note that the excluded and included participants differed in terms of age and parental education (see Table 1). Approximately 41.36 % (591 out of 1,429) of students were lost to follow-up between Wave 1 and Wave 12 in this study. The most common reasons for attrition were transitioning to the next grade level school, while a small number of students declined to participate in the follow-up. The study received approval from the Medical Ethics Review Committee of Chongqing Medical University.

2.2. Depression and anxiety

Depression and anxiety were measured by Children's Depression Inventory (CDI (Kovacs, 1981)) and Screen for Child Anxiety Related Disorders (SCARED (Birmaher et al., 1997)). CDI consists of 27 items, each of which is evaluated on a scale of 0–2, for a total score of 54. According to previous research, the measure has five dimensions: anhedonia, negative affect, negative self-esteem, ineffectiveness and interpersonal problems. In the present study, the Cronbach's Alpha of this scale was 0.73 (95 %CI: 0.71, 0.76). The 41-item of SCARED assesses five dimensions of anxiety: generalized anxiety symptoms (9 items), separation anxiety symptoms (8 items), social anxiety symptoms (7 items), panic or somatic symptoms (13 items), and school avoidance (4 items). Each item has three possible responses (0: Not True or Hardly Ever True,1: Somewhat or Sometimes True, 2: Very True or Often True). The Cronbach's Alpha of this scale was 0.95 (95 %CI: 0.94, 0.96) in this

Table 1
Wave 1 characteristics between included and excluded participants.

Characteristic	Exclude, N = 591[1]	Include, N = 838[1]	t/χ2	*P* value [2]
Age	8.93 (1.29)	8.62 (1.15)	4.66	<0.001
Gender			0.30	0.586
Male	293 (49.58 %)	402 (47.97 %)		
Female	298 (50.42 %)	436 (52.03 %)		
Father's education			19.70	<0.001
≤ Primary school	43 (7.30 %)	83 (9.90 %)		
Middle school	389 (66.04 %)	611 (72.91 %)		
≥ Junior college	157 (26.66 %)	144 (17.18 %)		
Mother's education			19.76	<0.001
≤ Primary school	95 (16.13 %)	142 (16.97 %)		
Middle school	354 (60.10 %)	573 (68.46 %)		
≥ Junior college	140 (23.77 %)	122 (14.58 %)		
Parents' divorce			<0.01	>0.999
YES	57 (9.68 %)	81 (9.67 %)		
No	532 (90.32 %)	757 (90.33 %)		
Family income monthly (RMB)			1.02	0.599
< 1000	180 (30.51 %)	259 (30.94 %)		
2000–4000	262 (44.41 %)	387 (46.24 %)		
>4000	148 (25.08 %)	191 (22.82 %)		

[1] n (%); Mean (SD).
[2] The P value were tested by Pearson's Chi-squared test; Fisher's exact test.

study.

2.3. Screen time

Two items examined average media screen time on school days and weekends. "In the past six months, on average, how many minutes per day did you spend watching TV, using a computer, or playing with a smartphone on weekdays (Monday to Friday) ", "In the past six months, on average, how many minutes per day did you spend watching TV, using a computer, or playing with a smartphone on weekends (Saturday and Sunday)?". The two items were reported by parents from wave 1 to wave 9, and self-reported by the participants from wave 10 to wave 11. The daily average screen time was calculated: [weekday screen time × 5] + [weekend screen time × 2]) ÷ 7. Finally, the average screen time was used in trajectory analysis.

2.4. Covariates

Based on previous studies (Li et al., 2021; Maras et al., 2015), we developed model 1 to control for age and gender at wave 1. Additionally, we constructed a Directed Acyclic Graphs (DAGs, in Supplementary, S1) based on prior literature review to derive the most plausible causal diagrams for the effects of screen time trajectory, respectively. With a simple set of rules, we used dagitty.net to determine the minimal adjustment sets required for confounding control. Specifically, erroneous adjustment for mediating variables (e.g., sedentary behavior (Wang et al., 2019), parental relationships (J. Wang et al., 2021) physical activity (Forte et al., 2023)) may introduce the bias in the relationship between screen time trajectory and depression and anxiety. As a result, we finally adjusted parents' divorce, parental education, screen time, and family income at wave 1 in model 2. Parental relationship, parents' divorce, parental education level, and family income in wave 1 were reported by parents. Of the participants, two individuals missed parental relationships, one individual missed family income and three missed screen time in wave 1. We used the mean value for their imputation.

2.5. Statistical analysis

First, a latent class growth model (LCGA) was used to classify participants into latent classes based on screen time trajectories The criteria (Nagin & Odgers, 2010) for determining the final trajectory class were: 1) Akaikei Information Criterion (AIC) and Bayesian Information Criterion (BIC) closer to 0 indicating a better fit; 2) The average posterior probability (AvePP) of an individual in each class should be greater than or equal to 0.7; 3) The lowest proportion of trajectories (Lowest Proportion) should be no less than 5 % of the total study population (Nagin, 2005). The Odds of Correct Classification (OCC), which measures the ratio of the probability of being correctly classified into each group, is generally considered to indicate high classification accuracy when OCC > 5.

Further, for handling comorbidity, we used latent profile analysis (LPA) to explore the subtypes of comorbidity of depression and anxiety. The z-score of dimensions of SCARE and CDI scale were used to fit the model using the R package "tidyLPA". The lowest BIC and Bootstrap Likelihood Ratio Test (BLRT) was conducted to determine the final latent class (Sinha et al., 2021).

Finally, logistic regression to explore the relationship of screen time trajectory on depression and anxiety subtypes. In this model, screen time trajectories were the predictors, with the outcomes being the subtypes of LPA for depression and anxiety. We also conducted an interaction analysis to examine the effects of age, gender, and other factors by including product terms to evaluate potential multiplicative interactions. All P −values are for two-sided hypothesis testing with a significance level of 0.05. All statistical analyses were performed in SAS 9.4, except for the LPA which was conducted in R 4.3.1.

3. Results

3.1. The trajectory analysis of screen time

There were 838 participants (52.03 % female; mean age in wave 1 = 8.62, SD = 1.15) included in the trajectory analysis. The average number of follow-up assessments for these participants was 10.73 (5.37 years), ranging from 7 to 11 times. Supplementary S2 provides information on screen time and the number of participants at each follow-up. We expanded the number of classes from one to four and determined that the three-group model produced the best fit. As shown in Supplementary S3, the BIC of the three-group model was closer to 0, indicating a better fit compared to the one-group model. The lowest group membership was 5.37 % (>5%), which was also higher than the four-group model (4.06 %).

The average posterior probability for each subgroup exceeded 70 %, indicating high assignment accuracy. Additionally, the OCC for each subgroup in the three groups was higher than 5.0, further confirming the accuracy of the subgroup assignments (Table 2). From wave 1 to wave 12, Group Low (68.26 %) had consistently low screen time; Group High (26.37 %) had high screen time with steady growth and Group Increasing (5.37 %) was characterized by highly increasing screen time from high screen time and ended with very high screen time (Fig. 1). Basic characteristics in wave 1 by group were available in Table 3. No statistically significant differences were observed among respondents of the different trajectories, except for age and mother's education.

Table 2
The model fit statistics of best model.

Group	n(%)	AvePP	OCC	Estimated proportion(%)
Group Low	572(68.26)	0.95	9.35	67.02
Group High	221(26.37)	0.90	23.68	27.54
Group Increasing	45(5.37)	0.97	562.82	5.43

Abbreviations: AvePP Average posterior probability, OCC, Odds of correct classification.

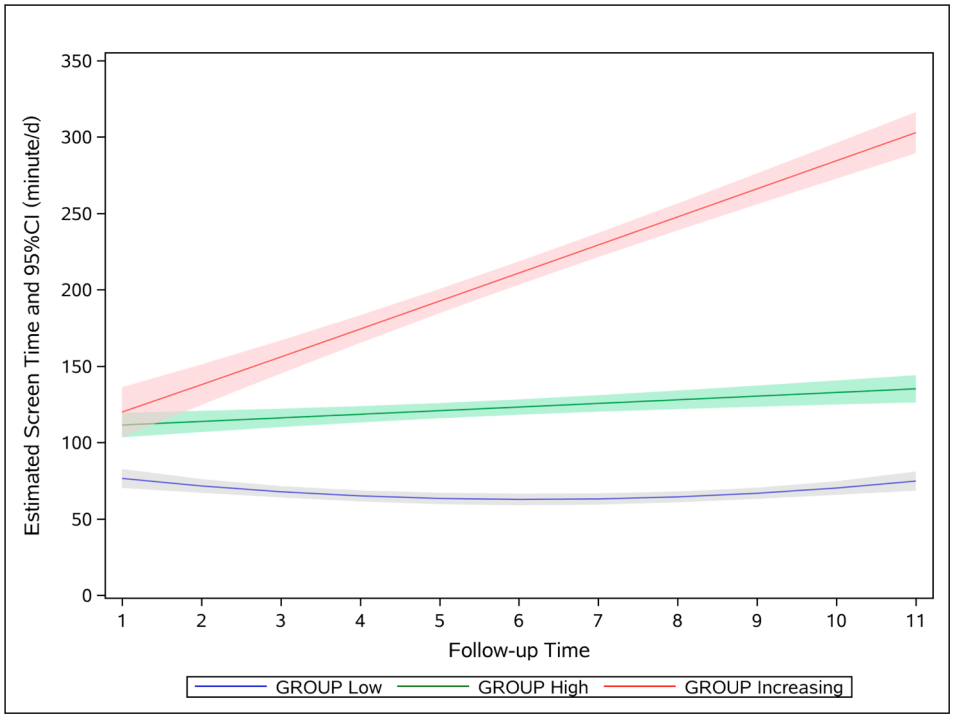

Fig. 1. The trajectories of screen time from wave1 to wave11.

3.2. The association between screen time trajectory with the comorbidity of depression and anxiety

Furthermore, we identified four subtypes of depression and anxiety using LPA. The criteria from 1 to 5 numbers of class was available in Table 4. We finally chose a four-category model after considering the practical significance, and proportion of the smallest class (Lowest Proportion). High comorbidity (n = 53,6.32 %) was "high comorbidity symptoms" which had a high probability on the anxiety and depression items. Low comorbidity (n = 154,18.38 %) was "low anxiety and low depression symptoms" which had a comparable probability on anxiety score and depression score. Low depression (n = 197,23.51 %) was "low depression symptoms" which had a comparable probability only on depression score and lower anxiety score. No symptoms (n = 434, 51.79 %) was "no depression and anxiety symptoms", which has the lowest score of CDI and SCARE (Fig. 2). The differences between LPA and binary classification were also shown in Table 5. Basic characteristics in wave 1 by subtypes of depression and anxiety can be seen in Supplementary S4. The subtypes of depression and anxiety have significant gender differences.

High screen time trajectory was more likely to be "Low comorbidity" (OR = 2.49, 95 % CI: 1.61–3.84, $P < 0.001$) and "Low depression" (OR = 2.07, 95 % CI: 1.38–3.12, $P < 0.001$) than low screen time trajectory. Increasing screen time trajectory was more likely to be "high comorbidity symptoms" (OR = 3.24, 95 % CI: 1.04–10.11, $P = 0.043$), "low comorbidity symptoms" (OR = 2.75, 95 % CI: 1.18–6.43, $P = 0.020$) and "Low depression" (OR = 2.76, 95 % CI:1.26–6.09, $P = 0.012$) than low screen time trajectory (Table 6).

3.3. Interactive analysis

The interaction between gender and screen time trajectory was the only significant interaction term. Our interactive analysis revealed that the interaction between gender and trajectory was statistically significant specifically within the high comorbidity group (Supplementary, S5). Consequently, we proceeded to conduct a subgroup analysis based on gender and discovered that girls (OR = 3.56, 95 %CI: 1.52–8.33, $P = 0.003$) had a higher likelihood of experiencing high comorbidity within the High screen time trajectory, compared to boys (OR = 0.59, 95 %CI: 0.15–2.38, $P = 0.461$) (Supplementary, S6).

4. Discussion

In this study, we analyzed the trajectories of screen time among children and adolescents from Wave 1 to Wave 11, resulting in the identification of three distinct trajectory groups: Group Low, Group High, and Group Increasing. Subsequently, we categorized depression and anxiety in Wave 12 into four subtypes: "High comorbidity," "Low comorbidity," "Low depression symptoms," and "No symptoms." We observed that the increasing screen time trajectory was more commonly associated with the "high comorbidity" subtype among both boys and girls. However, the high screen time trajectory specifically demonstrated an association with the "high comorbidity" subtype in girls.

There are three distinct screen time trajectory groups in children and adolescents. A majority of the population fell into the low screen time trajectory, while only a small minority were categorized into Increasing screen time trajectory, which was consistent with existing trajectory classifications (J. McVeigh et al., 2016; J. A. McVeigh et al., 2016). We found that higher age and lower levels of maternal education were associated with longer screen time trajectories for children. This finding is consistent with previous research (Abdel Magid et al., 2021; Cárdenas-Fuentes et al., 2022). The family's screen environment may serve as a mediator in the relationship between maternal education and children's video viewing patterns (Hesketh et al., 2007). Specifically, lower maternal education levels appear to be linked to increased maternal screen time, which, in turn, tends to facilitate more shared screen activities, such as co-viewing television, thereby contributing to greater video exposure for children (Pons et al., 2020).

For a more in-depth exploration of the comorbidity of depression and anxiety, we fitted a latent profile analysis, identifying four subtypes of depression and anxiety. This result was consistent with previous studies (Sun et al., 2023). We confirmed the significant heterogeneity in the comorbidity of depression and anxiety in children and adolescents. In comparison to the binary classification of single disorders, we found that

Table 3
Basic characteristics in wave1 by screen time trajectory.

	N = 838[1]	Group Low(n = 572)[1]	Group High(n = 221)[1]	Group Increasing(n = 45)[1]	*P* value[2]
Age in wave1 (Mean (SD))	8.62 (1.15)	8.50 (1.09)	8.85 (1.24)	9.07 (1.12)	<0.001*
Gender					0.546
Male	402 (47.97 %)	267 (46.68 %)	112 (50.68 %)	23 (51.11 %)	
Female	436 (52.03 %)	305 (53.32 %)	109 (49.32 %)	22 (48.89 %)	
Parental relationship					0.825
Excellent	538 (64.20 %)	374 (65.38 %)	135 (61.09 %)	29 (64.44 %)	
Good	162 (19.33 %)	110 (19.23 %)	46 (20.81 %)	6 (13.33 %)	
Average	95 (11.34 %)	59 (10.31 %)	28 (12.67 %)	8 (17.78 %)	
Not very good	28 (3.34 %)	19 (3.32 %)	8 (3.62 %)	1 (2.22 %)	
Poor	15 (1.79 %)	10 (1.75 %)	4 (1.81 %)	1 (2.22 %)	
Parents' divorce					0.528
Yes	81 (9.67 %)	52 (9.09 %)	23 (10.41 %)	6 (13.33 %)	
No	757 (90.33 %)	520 (90.91 %)	198 (89.59 %)	39 (86.67 %)	
Father's education					0.089
≤ Primary school	83 (9.90 %)	51 (8.92 %)	27 (12.22 %)	5 (11.11 %)	
Middle school and high school	611 (72.91 %)	410 (71.68 %)	165 (74.66 %)	36 (80.00 %)	
≥ Junior college	144 (17.18 %)	111 (19.41 %)	29 (13.12 %)	4 (8.89 %)	
Mother's education					0.039*
≤ Primary school	142 (16.95 %)	87 (15.21 %)	45 (20.36 %)	10 (22.22 %)	
Middle school and high school	573 (68.38 %)	388 (67.83 %)	153 (69.23 %)	32 (71.11 %)	
≥ Junior college	123 (14.68 %)	97 (16.96 %)	23 (10.41 %)	3 (6.67 %)	
Family income monthly (RMB)					0.560
< 2000	259 (30.91 %)	171 (29.90 %)	73 (33.03 %)	15 (33.33 %)	
2000–4000	388 (46.30 %)	267 (46.68 %)	104 (47.06 %)	17 (37.78 %)	
>4000	191 (22.79 %)	134 (23.43 %)	44 (19.91 %)	13 (28.89 %)	

[1] n (%).
[2] The *P* value were tested by One-way ANOVA; Pearson's Chi-squared test; Fisher's exact test.

depression and anxiety not only correlated at the high score (high co-morbidity symptoms) but also correlated at moderate score (low co-morbidity symptoms). Furthermore, the results did not reveal the presence of high anxiety and low depression symptoms. High anxiety may be often accompanied by high depression, while high depression can be associated with either high or low anxiety in children and adolescents. This result is less consistent with previous theories of depression and anxiety comorbidity (Cummings et al., 2014). Prior theories of co-morbidity suggested that anxious youth were more likely to report high levels of anxiety accompanied by low levels of depression (van Lang et al., 2006), possibly due to generational (Botha et al., 2023) as well as racial differences (Ochnik et al., 2021). The comorbidity of depression and anxiety may be influenced by the era in which it occurs. Our study was conducted during the COVID-19 pandemic, a period that likely presents a higher risk for the onset of depression and anxiety compared to other times (Hawes et al., 2022). In addition, different ethnic groups may impact the classification of comorbidity. Recent studies have suggested that the increase in depressive and anxiety symptoms is more pronounced among Asians than in other racial groups (Prichett et al., 2024).

Furthermore, we explored the association between screen time trajectory and different subtypes of the comorbidity of anxiety and depression. We found that Increasing screen time trajectory was more likely to be "high comorbidity symptoms" for both boys and girls. There are some possible explanations between screen time trajectory and depression-anxiety comorbidity. In our study, age may be a very important factor due to age was higher in both the High comorbidity and Increasing screen time trajectory. Previous research has shown that screen time for social purposes increases with age, while time spent watching television remains relatively constant (Zhu et al., 2023). Increased online social engagement may elevate the risk of exposure to cyberbullying, which can, in turn, contribute to the development of depression and anxiety in adolescents. Moreover, the influence of screen time trajectory on High comorbidity of adolescents may be resulted from mother education. Our study indicated that Increasing screen time trajectory had lower maternal education. Lower mother education may provide more negative help and support for children's growth such as lower level of educational participation (Jablonska et al., 2012) and worse parent–child relationships (Holstein et al., 2021), which were associated with depressive symptoms of adolescents (Xiang et al., 2024). Previous studies have also found that increasing screen time trajectories may be accompanied by decreasing physical activity and sleep time trajectories, which can negatively impact depression and anxiety in children and adolescents (del Pozo-Cruz et al., 2019; Zhang et al., 2021). Moreover, the increased screen time may come more from the internet using (Zhu et al., 2023), thus increasing cyberbullying which was associated with depression and anxiety (O'Keeffe et al., 2011). Finally, recent studies indicated that there were bidirectional associations between screen time and children's internalizing behavior (Neville et al., 2021). High depressive symptoms trajectory may affect later screen time (Zhu et al., 2023), while anxiety-related studies are lacking. Thus, high comorbidity may also contribute to high increasing screen time trajectory.

Finally, High screen time trajectory was associated with "high co-morbidity" only in girls. This may be attributed to many psychosocial factors. Compared to boys who prefer spending time on gaming, girls may tend to spend more screen time on social media (Twenge & Farley, 2021), which increases the chance of exposure to cyberbullying (Hoge et al., 2017). Moreover, girls were more likely to occur depression (Breslau et al., 2017), due to reproductive hormones biological factors (Hyde et al., 2008). Finally, girls compared to boys exhibited more susceptibility for highly negative stimuli and a lower threshold of responding to negative stimuli, regardless of puberty (Yang et al., 2018).

Table 4
The criteria for different class number.

Class Number	AIC	BIC	Entropy	Lowest AvePP	Lowest Proportion	BLRT_*p*
1	23811.40	23906.02	1.00	1.00	1.00	
2	20875.56	21022.23	0.94	0.96	0.25	0.01
3	20012.12	20210.82	0.91	0.93	0.09	0.01
4	19604.75	19855.49	0.88	0.85	0.06	0.01
5	19255.80	19558.59	0.88	0.86	0.04	0.01

Abbreviations: BIC, Bayesian information criteria, AIC, Akaike's information criterion, AvePP Average posterior probability, BLRT_*p*, Bootstrap likelihood ratio test p value.

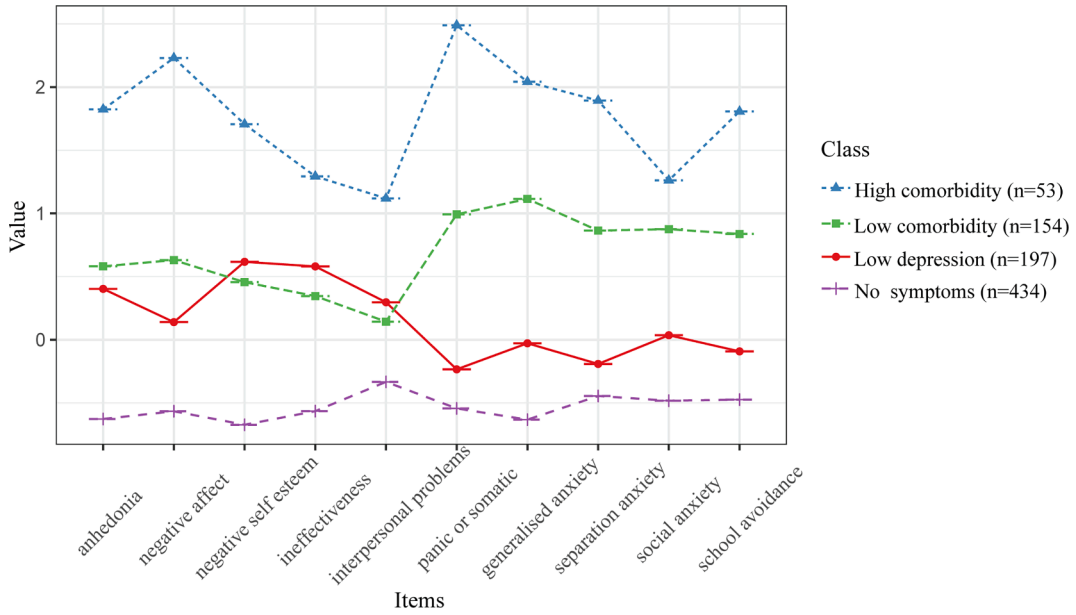

Fig. 2. The profile of the dimensions of SCARE and CDI Scales in wave12. Note: "Value" of the y-axis represents the z-score of dimensions of SCARE and CDI scale.

Table 5
The differences between LPA and binary classification.

	High comorbidity (n = 53)	Low comorbidity (n = 154)	Low depression (n = 197)	No symptoms (n = 434)
Depression				
Yes	52 (98.11 %)	64 (41.56 %)	58 (29.44 %)	0 (0.00 %)
Anxiety				
Yes	53 (100 %)	137 (88.96 %)	7 (3.55 %)	5 (1.15 %)

Note:Depression was defined by a total score of 19 or higher (Timbremont et al., 2004), Anxiety was defined by a total score of 25 or higher (Rappaport et al., 2017).

4.1. Limitations and future direction

It is important to acknowledge the limitations of this study. Firstly, the assessment of screen time relied on self-reported and parent-reported in the past six months on average, which may introduce measurement and recall biases. Measuring screen time in young children has long been a challenge, with the primary methods including self-reports, parent reports, and wearable device measurement (Browne et al., 2021). A systematic review indicated that screen time for younger children was still predominantly assessed through parent reports (Eirich et al., 2022). However, it is inevitable that parent-reported screen time may underestimate the actual screen time of children (McArthur et al., 2021). Although the discrepancy is not substantial (Forte et al., 2023), this could lead to an overrepresentation of children in the lower screen time trajectory. Future research could utilize wearable devices (Perez et al., 2023) to directly measure screen time exposure, allowing for a more accurate fitting of screen time trajectories in children and adolescents. Furthermore, our study solely focused on total screen time and future research could explore the association between specific screen time purposes and depression and anxiety. Additionally, the comorbidity of depression and anxiety in our study was based on a cross-sectional design, but recent research indicated that only a few children and adolescents changed latent class membership over time (Göbel et al., 2022). For this reason, it becomes challenging to conduct an analysis on whether poor mental health leads to increased screen time. Finally, the assessments of depression and anxiety were conducted during COVID-19 pandemic in Chongqing, China. This is crucial to consider as the prevalence of depressive and anxiety symptoms, as well as screen time, may have increased due to school and home confinement for children and adolescents (Hawes et al., 2022).

5. Conclusions

The present study used two "person-centered" methods (LCGM and LPA) to contribute novel findings of adolescent mental health research by highlighting the comorbidity of depression and anxiety. Our study stands as the first to report on the association between screen time trajectories and the comorbidity of depression and anxiety. It demonstrated that increasing screen time trajectories were associated with poorer comorbid subtypes of depression and anxiety. Notably, a high and stable screen time trajectory in girls but not boys appears to be associated with a higher risk of high comorbidity, compared to low screen time trajectory. These findings highlight the significance of considering comorbid subtypes in the prevention and management of depression and anxiety, which may provide a reference for more targeted interventions for

Table 6
The association between screen time trajectory with the class of the comorbidity of anxiety and depression.

	Model1[1]			Model2[2]		
	OR	*95 %CI*	*P*	*OR*	*95 %CI*	*P*
High comorbidity						
Group Low	1.00			1.00		
Group High	1.88	0.97,3.62	0.060	1.91	0.96,3.78	0.064
Group Increasing	3.32	1.11,9.90	0.032*	3.24	1.04,10.11	0.043*
Low comorbidity						
Group Low	1.00			1.00		
Group High	2.43	1.60,3.68	<0.001*	2.49	1.61,3.84	<0.001*
Group Increasing	2.72	1.20,6.18	0.017*	2.75	1.18, 6.43	0.020*
Low depression symptoms						
Group Low	1.00			1.00		
Group High	1.96	1.32,2.89	<0.001*	2.07	1.38,3.12	<0.001*
Group Increasing	2.54	1.18,5.45	0.017*	2.76	1.26,6.09	0.012*

Note: Logistic regression of screen time trajectories with the subtypes of depression and anxiety.
[1] : Adjusted for age in wave1, gender.
[2] : Adjusted for age in wave1, gender, screen time in wave1, parents' divorce, parental education level, and family income in wave1.
* $p < 0.05$.

comorbid conditions in clinical practice. Additionally, identifying patterns of change in screen time, particularly growth trajectories in children and adolescents, may serve as a useful indicator for recognizing comorbid depression and anxiety. Finally, appropriate interventions should be implemented to address screen time usage trajectories in individuals with comorbidities, in order to mitigate the potential negative impact of screen time on the co-occurrence of depression and anxiety.

6. Financial support

This work was supported by Natural Science Foundation of Chongqing, China [Grant number: CSTB2023NSCQ-MSX0133], National Natural Science Foundation of China [Granted number: 81973067], Young Scientists Fund of the National Natural Science Foundation of China [Granted number: 81502825], and Program for Youth Innovation in Future Medicine, Chongqing Medical University (W0054).

CRediT authorship contribution statement

Jie Zhang: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Xinyi Feng:** Writing – original draft, Formal analysis, Data curation. **Qin Zhang:** Methodology, Formal analysis. **Di Wu:** Writing – review & editing. **Wenhe Wang:** Data curation. **Shudan Liu:** Data curation. **Qin Liu:** Methodology, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We thank all the children and their parents for their participation, and the teachers in four primary schools and eight middle schools for their kind support. Many thanks to all the students who participated in the data collection.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.addbeh.2025.108260.

Data availability

Data will be made available on request.

References

Abdel Magid, H. S., Milliren, C. E., Pettee Gabriel, K., & Nagata, J. M. (2021). Disentangling individual, school, and neighborhood effects on screen time among adolescents and young adults in the United States. *Preventive medicine, 142*, Article 106357. https://doi.org/10.1016/j.ypmed.2020.106357

Altamura, A. C., Montresor, C., Salvadori, D., & Mundo, E. (2004). Does comorbid subthreshold anxiety affect clinical presentation and treatment response in depression? A preliminary 12-month naturalistic study. *International Journal of Neuropsychopharmacology, 7*(4), 481–487. https://doi.org/10.1017/s1461145704004626

Altemus, M., Sarvaiya, N., & Neill Epperson, C. (2014). Sex differences in anxiety and depression clinical perspectives. *Frontiers in Neuroendocrinology, 35*(3), 320–330. https://doi.org/10.1016/j.yfrne.2014.05.004

Alvarez de Mon, M. A., Sánchez-Villegas, A., Gutiérrez-Rojas, L., & Martinez-Gonzalez, M. A. (2024). Screen exposure, mental health and emotional well-being in the adolescent population: Is it time for governments to take action? *Journal of Epidemiology and Community Health, 78*(12), 759. https://doi.org/10.1136/jech-2023-220577

Auerbach, R. P., Pagliaccio, D., Hubbard, N. A., Frosch, I., Kremens, R., Cosby, E., & Pizzagalli, D. A. (2022). Reward-related neural circuitry in depressed and anxious adolescents: A human connectome project. *Journal of the American Academy of Child & Adolescent Psychiatry, 61*(2), 308–320. https://doi.org/10.1016/j.jaac.2021.04.014

Avenevoli, S., Stolar, M., Li, J., Dierker, L., & Ries Merikangas, K. (2001). Comorbidity of depression in children and adolescents: Models and evidence from a prospective high-risk family study. *Biological Psychiatry, 49*(12), 1071–1081. https://doi.org/10.1016/S0006-3223(01)01142-8

Axelson, D. A., & Birmaher, B. (2001). Relation between anxiety and depressive disorders in childhood and adolescence. *Depression and Anxiety, 14*(2), 67–78. https://doi.org/10.1002/da.1048

Birmaher, B., Khetarpal, S., Brent, D., Cully, M., Balach, L., Kaufman, J., & Neer, S. M. (1997). The Screen for Child Anxiety Related Emotional Disorders (SCARED): scale construction and psychometric characteristics. *Journal of the American Academy of Child & Adolescent Psychiatry, 36*(4), 545–553. https://doi.org/10.1097/00004583-199704000-00018

Bita, S., Parviz, A., & Hojjatollah, F. (2021). Correlates of screen time in children and adolescents: A systematic review study. *Journal of Modern Rehabilitation, 15*(4). https://doi.org/10.18502/jmr.v15i4.7740

Botha, F., Morris, R. W., Butterworth, P., & Glozier, N. (2023). Generational differences in mental health trends in the twenty-first century. *Proceedings of the National Academy of Sciences, 120*(49), Article e2303781120. https://doi.org/10.1073/pnas.2303781120

Breslau, J., Gilman, S. E., Stein, B. D., Ruder, T., Gmelin, T., & Miller, E. (2017). Sex differences in recent first-onset depression in an epidemiological sample of adolescents. *Translational Psychiatry, 7*(5), e1139–e. https://doi.org/10.1038/tp.2017.105

Browne, D. T., May, S. S., Colucci, L., Hurst-Della Pietra, P., Christakis, D., Asamoah, T., & Prime, H. (2021). From screen time to the digital level of analysis: A scoping review of measures for digital media use in children and adolescents. *BMJ Open, 11*(5), Article e046367. https://doi.org/10.1136/bmjopen-2020-046367

Cárdenas-Fuentes, G., Homs, C., Ramírez-Contreras, C., Juton, C., Casas-Esteve, R., Grau, M., & Schröder, H. (2022). Prospective association of maternal educational

level with child's physical activity, screen time, and diet quality. *Nutrients, 14*(1), 160. https://www.mdpi.com/2072-6643/14/1/160.
Carson, V., & Kuzik, N. (2017). Demographic correlates of screen time and objectively measured sedentary time and physical activity among toddlers: A cross-sectional study. *BMC Public Health, 17*(1), 187. https://doi.org/10.1186/s12889-017-4125-y
Cummings, C. M., Caporino, N. E., & Kendall, P. C. (2014). Comorbidity of anxiety and depression in children and adolescents: 20 years after. *Psychological Bulletin, 140*(3), 816–845. https://doi.org/10.1037/a0034733
del Pozo-Cruz, B., Perales, F., Parker, P., Lonsdale, C., Noetel, M., Hesketh, K. D., & Sanders, T. (2019). Joint physical-activity/screen-time trajectories during early childhood: Socio-demographic predictors and consequences on health-related quality-of-life and socio-emotional outcomes. *International Journal of Behavioral Nutrition and Physical Activity, 16*(1), 55. https://doi.org/10.1186/s12966-019-0816-3
Delisle Nyström, C., Carlander, A., Cassel, S., Rosell, M., J-Son Höök, M., & Löf, M. (2023). Physical activity and screen time in Swedish children and adolescents: The generation pep study 2018–2021. *Acta Paediatrica*, *112*(3), 460-468. doi: 10.1111/apa.16594.
Eirich, R., McArthur, B. A., Anhorn, C., McGuinness, C., Christakis, D. A., & Madigan, S. (2022). Association of screen time with internalizing and externalizing behavior problems in children 12 years or younger: A systematic review and meta-analysis. *JAMA Psychiatry, 79*(5), 393–405. https://doi.org/10.1001/jamapsychiatry.2022.0155
Fang, K., Mu, M., Liu, K., & He, Y. (2019). Screen time and childhood overweight/obesity: A systematic review and meta-analysis. *Child: Care, Health and Development, 45*(5), 744–753. https://doi.org/10.1111/cch.12701
Forte, C., O'Sullivan, D., McDowell, C. P., Hallgren, M., Woods, C. B., & Herring, M. P. (2023). Associations between screen-time, physical activity and depressive symptoms differ based on gender and screen-time mode. *European Child & Adolescent Psychiatry, 32*(11), 2313–2322. https://doi.org/10.1007/s00787-022-02080-w
Göbel, K., Ortelbach, N., Cohrdes, C., Baumgarten, F., Meyrose, A.-K., Ravens-Sieberer, U., & Scheithauer, H. (2022). Co-occurrence, stability and manifestation of child and adolescent mental health problems: A latent transition analysis. *BMC Psychology, 10*(1), 267. https://doi.org/10.1186/s40359-022-00969-4
Hale, L., & Guan, S. (2015). Screen time and sleep among school-aged children and adolescents: A systematic literature review. *Sleep Medicine Reviews, 21*, 50–58. https://doi.org/10.1016/j.smrv.2014.07.007
Hawes, M. T., Szenczy, A. K., Klein, D. N., Hajcak, G., & Nelson, B. D. (2022). Increases in depression and anxiety symptoms in adolescents and young adults during the COVID-19 pandemic. *Psychological Medicine, 52*(14), 3222–3230. https://doi.org/10.1017/S0033291720005358
Hesketh, K., Ball, K., Crawford, D., Campbell, K., & Salmon, J. (2007). Mediators of the relationship between maternal education and children's TV viewing. *American Journal of Preventive Medicine, 33*(1), 41–47. https://doi.org/10.1016/j.amepre.2007.02.039
Hoge, E., Bickham, D., & Cantor, J. (2017). Digital media, anxiety, and depression in children. *Pediatrics, 140*(Supplement_2), S76–S80. https://doi.org/10.1542/peds.2016-1758G
Holstein, B. E., Pant, S. W., Ammitzbøll, J., Laursen, B., Madsen, K. R., Skovgaard, A. M., & Pedersen, T. P. (2021). Parental education, parent–child relations and diagnosed mental disorders in childhood: Prospective child cohort study. *European Journal of Public Health, 31*(3), 514–520. https://doi.org/10.1093/eurpub/ckab053
Hyde, J. S., Mezulis, A. H., & Abramson, L. Y. (2008). The ABCs of depression: Integrating affective, biological, and cognitive models to explain the emergence of the gender difference in depression. *Psychological Review, 115*(2), 291–313. https://doi.org/10.1037/0033-295X.115.2.291
Jablonska, B., Lindblad, F., Östberg, V., Lindberg, L., Rasmussen, F., & Hjern, A. (2012). A national cohort study of parental socioeconomic status and non-fatal suicidal behaviour-the mediating role of school performance. *BMC Public Health, 12*(1), 17. https://doi.org/10.1186/1471-2458-12-17
Kalin, N. H. (2020). The critical relationship between anxiety and depression. *Am J Psychiatry, 177*(5), 365–367. https://doi.org/10.1176/appi.ajp.2020.20030305
Kircanski, K., LeMoult, J., Ordaz, S., & Gotlib, I. H. (2017). Investigating the nature of co-occurring depression and anxiety: Comparing diagnostic and dimensional research approaches. *Journal of Affective Disorders, 216*, 123–135. https://doi.org/10.1016/j.jad.2016.08.006
Kovacs, M. (1981). Rating scales to assess depression in school-aged children. *Acta Paedopsychiatrica: International Journal of Child & Adolescent Psychiatry, 46*(5–6), 305–315.
Lahey, B. B., Tiemeier, H., & Krueger, R. F. (2022). Seven reasons why binary diagnostic categories should be replaced with empirically sounder and less stigmatizing dimensions. *JCPP Advances, 2*(4), Article e12108. https://doi.org/10.1002/jcv2.12108
Li, X., Vanderloo, L. M., Keown-Stoneman, C. D. G., Cost, K. T., Charach, A., Maguire, J. L., & Birken, C. S. (2021). Screen use and mental health symptoms in Canadian children and youth during the COVID-19 pandemic. *JAMA Network Open, 4*(12), Article e2140875. https://doi.org/10.1001/jamanetworkopen.2021.40875
Lissak, G. (2018). Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study. *Environmental Research, 164*, 149–157. https://doi.org/10.1016/j.envres.2018.01.015
Liu, S., Liu, Q., Ostbye, T., Story, M., Deng, X., Chen, Y., & Zhang, J. (2017). Levels and risk factors for urinary metabolites of polycyclic aromatic hydrocarbons in children living in Chongqing, China. *Science of The Total Environment, 598*, 553–561. https://doi.org/10.1016/j.scitotenv.2017.04.103
Liu, Y., Li, S., Deng, T., Li, L., Wei, R., Zhang, Y., & Wan, Y. (2024). The association between green space around schools, screen time for entertainment, and adolescent depressive symptoms: A nationwide study from China. *Environmental Research, 263*, Article 120100. https://doi.org/10.1016/j.envres.2024.120100
Maras, D., Flament, M. F., Murray, M., Buchholz, A., Henderson, K. A., Obeid, N., & Goldfield, G. S. (2015). Screen time is associated with depression and anxiety in Canadian youth. *Preventive Medicine, 73*, 133–138. https://doi.org/10.1016/j.ypmed.2015.01.029
Maurizio Fava, M. D., A. John Rush, M. D., Jonathan E. Alpert, M. D., Ph.D., G. K. Balasubramani, P. D., Stephen R. Wisniewski, P. D., Cheryl N. Carmin, P. D., . . . Madhukar H. Trivedi, M. D. (2008). Difference in Treatment Outcome in Outpatients With Anxious Versus Nonanxious Depression: A STAR*D Report. *American Journal of Psychiatry*, *165*(3), 342-351. doi: 10.1176/appi.ajp.2007.06111868.
McArthur, B. A., Racine, N., Browne, D., McDonald, S., Tough, S., & Madigan, S. (2021). Recreational screen time before and during COVID-19 in school-aged children. *Acta Paediatrica, 110*(10), 2805–2807. https://doi.org/10.1111/apa.15966
McVeigh, J., Smith, A., Howie, E., & Straker, L. (2016). Trajectories of television watching from childhood to early adulthood and their association with body composition and mental health outcomes in young adults. *PLOS ONE, 11*(4), Article e0152879. https://doi.org/10.1371/journal.pone.0152879
McVeigh, J. A., Zhu, K., Mountain, J., Pennell, C. E., Lye, S. J., Walsh, J. P., & Straker, L. M. (2016). Longitudinal trajectories of television watching across childhood and adolescence predict bone mass at age 20 years in the raine study. *Journal of Bone and Mineral Research, 31*(11), 2032–2040. https://doi.org/10.1002/jbmr.2890
Montag, C., Demetrovics, Z., Elhai, J. D., Grant, D., Koning, I., Rumpf, H.-J., & van den Eijnden, R. (2024). Problematic social media use in childhood and adolescence. *Addictive Behaviors, 153*, Article 107980. https://doi.org/10.1016/j.addbeh.2024.107980
Nagata, J. M., Al-Shoaibi, A. A. A., Leong, A. W., Zamora, G., Testa, A., Ganson, K. T., & Baker, F. C. (2024). Screen time and mental health: A prospective analysis of the Adolescent Brain Cognitive Development (ABCD) Study. *BMC Public Health, 24*(1), 2686. https://doi.org/10.1186/s12889-024-20102-x
Nagin, D. S. (2005). Harvard University Press. doi: doi:10.4159/9780674041318.
Nagin, D. S., & Odgers, C. L. (2010). Group-Based Trajectory Modeling in Clinical Research. *Annual Review of Clinical Psychology*, *6*(Volume 6, 2010), 109-138. doi: 10.1146/annurev.clinpsy.121208.131413.
Neville, R. D., McArthur, B. A., Eirich, R., Lakes, K. D., & Madigan, S. (2021). Bidirectional associations between screen time and children's externalizing and internalizing behaviors. *Journal of Child Psychology and Psychiatry, 62*(12), 1475–1484. https://doi.org/10.1111/jcpp.13425
O'Keeffe, G. S., Clarke-Pearson, K., Communications, C. o., & Media. (2011). The Impact of Social Media on Children, Adolescents, and Families. *Pediatrics, 127*(4), 800-804. doi: 10.1542/peds.2011-0054.
Ochnik, D., Rogowska, A. M., Kuśnierz, C., Jakubiak, M., Schütz, A., Held, M. J., & Cuero-Acosta, Y. A. (2021). Mental health prevalence and predictors among university students in nine countries during the COVID-19 pandemic: A cross-national study. *Scientific Reports, 11*(1), 18644. https://doi.org/10.1038/s41598-021-97697-3
Perez, O., Garza, T., Hindera, O., Beltran, A., Musaad, S. M., Dibbs, T., & O'Connor, T. M. (2023). Validated assessment tools for screen media use: A systematic review. *PLOS ONE, 18*(4), Article e0283714. https://doi.org/10.1371/journal.pone.0283714
Pons, M., Bennasar-Veny, M., & Yañez, A. M. (2020). Maternal education level and excessive recreational screen time in children: a mediation analysis. *International Journal of Environmental Research and Public Health, 17*(23), 8930. https://www.mdpi.com/1660-4601/17/23/8930.
Preisig, M., Merikangas, K. R., & Angst, J. (2001). Clinical significance and comorbidity of subthreshold depression and anxiety in the community. *Acta Psychiatrica Scandinavica, 104*(2), 96–103. https://doi.org/10.1034/j.1600-0447.2001.00284.x
Prichett, L. M., Yolken, R. H., Severance, E. G., Carmichael, D., Zeng, Y., Lu, Y., & Kumra, T. (2024). COVID-19 and youth mental health disparities: intersectional trends in depression, anxiety and suicide risk-related diagnoses. *Academic Pediatrics, 24*(5), 837–847. https://doi.org/10.1016/j.acap.2024.01.021
Rao, W.-W., Xu, D.-D., Cao, X.-L., Wen, S.-Y., Che, W.-I., Ng, C. H., & Xiang, Y.-T. (2019). Prevalence of depressive symptoms in children and adolescents in China: A meta-analysis of observational studies. *Psychiatry Research, 272*, 790–796. https://doi.org/10.1016/j.psychres.2018.12.133
Rappaport, B. I., Pagliaccio, D., Pine, D. S., Klein, D. N., & Jarcho, J. M. (2017). Discriminant validity, diagnostic utility, and parent-child agreement on the Screen for Child Anxiety Related Emotional Disorders (SCARED) in treatment- and non-treatment-seeking youth. *Journal of Anxiety Disorders, 51*, 22–31. https://doi.org/10.1016/j.janxdis.2017.08.006
Rideout, V. (2016). Measuring time spent with media: The Common Sense census of media use by US 8- to 18-year-olds. *Journal of Children and Media, 10*(1), 138–144. https://doi.org/10.1080/17482798.2016.1129808
Santos, R. M. S., Mendes, C. G., Sen Bressani, G. Y., de Alcantara Ventura, S., de Almeida Nogueira, Y. J., de Miranda, D. M., & Romano-Silva, M. A. (2023). The associations between screen time and mental health in adolescents: A systematic review. *BMC Psychology, 11*(1), 127. https://doi.org/10.1186/s40359-023-01166-7
Shorey, S., Ng, E. D., & Wong, C. H. J. (2022). Global prevalence of depression and elevated depressive symptoms among adolescents: A systematic review and meta-analysis. *British Journal of Clinical Psychology, 61*(2), 287–305. https://doi.org/10.1111/bjc.12333
Sinha, P., Calfee, C. S., & Delucchi, K. L. (2021). Practitioner's guide to latent class analysis: Methodological considerations and common pitfalls. *Critical Care Medicine, 49*(1), e63–e79. https://doi.org/10.1097/ccm.0000000000004710
Sun, J., Wang, S., Mu, G., Liu, J., Su, R., Zhang, X., & Wang, Y. (2023). Symptoms of depression and anxiety in Chinese adolescents: Heterogeneity and associations with

executive function. *BMC Psychiatry, 23*(1), 410. https://doi.org/10.1186/s12888-023-04810-z

Takahashi, I., Obara, T., Ishikuro, M., Murakami, K., Ueno, F., Noda, A., & Kuriyama, S. (2023). Screen time at age 1 year and communication and problem-solving developmental delay at 2 and 4 years. *JAMA Pediatrics, 177*(10), 1039–1046. https://doi.org/10.1001/jamapediatrics.2023.3057

Tang, S., Werner-Seidler, A., Torok, M., Mackinnon, A. J., & Christensen, H. (2021). The relationship between screen time and mental health in young people: A systematic review of longitudinal studies. *Clinical Psychology Review, 86*, Article 102021. https://doi.org/10.1016/j.cpr.2021.102021

Timbremont, B., Braet, C., & Dreessen, L. (2004). Assessing depression in youth: relation between the children's depression inventory and a structured interview. *Journal of Clinical Child and Adolescent Psychology, 33*(1), 149–157. https://doi.org/10.1207/S15374424JCCP3301_14

Trinh, M.-H., Sundaram, R., Robinson, S. L., Lin, T.-C., Bell, E. M., Ghassabian, A., & Yeung, E. H. (2020). Association of trajectory and covariates of children's screen media time. *JAMA Pediatrics, 174*(1), 71–78. https://doi.org/10.1001/jamapediatrics.2019.4488

Twenge, J. M., & Farley, E. (2021). Not all screen time is created equal: Associations with mental health vary by activity and gender. *Social Psychiatry and Psychiatric Epidemiology, 56*(2), 207–217. https://doi.org/10.1007/s00127-020-01906-9

Twenge, J. M., & Martin, G. N. (2020). Gender differences in associations between digital media use and psychological well-being: Evidence from three large datasets. *Journal of Adolescence, 79*(1), 91–102. https://doi.org/10.1016/j.adolescence.2019.12.018

van Lang, N. D. J., Ferdinand, R. F., Ormel, J., & Verhulst, F. C. (2006). Latent class analysis of anxiety and depressive symptoms of the Youth Self-Report in a general population sample of young adolescents. *Behaviour Research and Therapy, 44*(6), 849–860. https://doi.org/10.1016/j.brat.2005.06.004

Vos, T., Lim, S. S., Abbafati, C., Abbas, K. M., Abbasi, M., Abbasifard, M., & Murray, C. J. L. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet, 396*(10258), 1204–1222. https://doi.org/10.1016/S0140-6736(20)30925-9

Wang, J., Wang, H., Lin, H., Richards, M., Yang, S., Liang, H., & Fu, C. (2021). Study problems and depressive symptoms in adolescents during the COVID-19 outbreak: Poor parent-child relationship as a vulnerability. *Globalization and Health, 17*(1), 40. https://doi.org/10.1186/s12992-021-00693-5

Wang, M., & Hanges, P. J. (2011). Latent class procedures: Applications to organizational research. *Organizational Research Methods, 14*(1), 24–31. https://doi.org/10.1177/1094428110383988

Wang, M., Mou, X., Li, T., Zhang, Y., Xie, Y., Tao, S., & Wu, X. (2023). Association between comorbid anxiety and depression and health risk behaviors among Chinese adolescents: Cross-sectional questionnaire study. *JMIR Public Health Surveill, 9*, Article e46289. https://doi.org/10.2196/46289

Wang, X., Li, Y., & Fan, H. (2019). The associations between screen time-based sedentary behavior and depression: A systematic review and meta-analysis. *BMC Public Health, 19*(1), 1524. https://doi.org/10.1186/s12889-019-7904-9

Wang, Y., Ge, F., Zhang, J., & Zhang, W. (2021). Heterogeneity in the co-occurrence of depression and anxiety symptoms among youth survivors: A longitudinal study using latent profile analysis. *Early Intervention in Psychiatry, 15*(6), 1612–1625. https://doi.org/10.1111/eip.13101

Xiang, Y., Cao, R., & Li, X. (2024). Parental education level and adolescent depression: A multi-country meta-analysis. *Journal of Affective Disorders, 347*, 645–655. https://doi.org/10.1016/j.jad.2023.11.081

Yang, J., Zhang, S., Lou, Y., Long, Q., Liang, Y., Xie, S., & Yuan, J. (2018). The increased sex differences in susceptibility to emotional stimuli during adolescence: An event-related potential study. *Frontiers in Human Neuroscience, 11*. https://doi.org/10.3389/fnhum.2017.00660

Zhang, A., Fang, J., Wan, Y., Su, P., Tao, F., & Sun, Y. (2021). Joint trajectories of life style indicators and their links to psychopathological outcomes in the adolescence. *BMC Psychiatry, 21*(1), 407. https://doi.org/10.1186/s12888-021-03403-y

Zhao, J., Yu, Z., Sun, X., Wu, S., Zhang, J., Zhang, D., & Jiang, F. (2022). Association between screen time trajectory and early childhood development in children in China. *JAMA Pediatrics, 176*(8), 768–775. https://doi.org/10.1001/jamapediatrics.2022.1630

Zhu, X., Griffiths, H., Xiao, Z., Ribeaud, D., Eisner, M., Yang, Y., & Murray, A. L. (2023). Trajectories of screen time across adolescence and their associations with adulthood mental health and behavioral outcomes. *Journal of Youth and Adolescence, 52*(7), 1433–1447. https://doi.org/10.1007/s10964-023-01782-x