


# BMJ Open Anxiety symptoms and associated factors among school students after 2 years of the COVID-19 pandemic: a cross-sectional study in Zhejiang Province, China

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## ABSTRACT

**Objectives** To ascertain the prevalence and associated factors of anxiety symptoms among middle and high school students in Zhejiang after 2 years of the COVID-19 pandemic.

**Design** A school-based cross-sectional study.

**Setting** 30 counties/districts in Zhejiang Province, China.

**Participants** 27 019 students attending middle and high schools.

**Outcome measures** Anxiety symptoms were assessed using the Generalised Anxiety Disorder 7-item scale (GAD-7). A total score of 10 or more is considered indicative of anxiety symptoms.

**Results** The overall prevalence (95% CI) of anxiety symptoms was 14.2% (13.4 to 15.0), higher among girls (18.6%, 95% CI: 17.5 to 19.7) than boys (10.2%, 95% CI: 9.5 to 10.9) ( $p<0.001$ ), higher among rural students (15.1%, 95% CI: 14.1 to 16.2) than urban students (12.5%, 95% CI: 11.6 to 13.4) ( $p<0.001$ ). Older age (14–15 years, OR=1.25, 95% CI: 1.09 to 1.44;  $\geq 16$  years, OR=1.32, 95% CI: 1.07 to 1.63), being girls (OR=1.76, 95% CI: 1.58 to 1.96), living in rural areas (OR=1.14, 95% CI: 1.01 to 1.29), poor academic performance (OR=1.20, 95% CI: 1.03 to 1.41), alcohol drinking (OR=1.15, 95% CI: 1.01 to 1.30), inadequate fruits (OR=1.31, 95% CI: 1.19 to 1.45) and vegetables intake (OR=1.32, 95% CI: 1.10 to 1.57), insomnia (sometimes, OR=2.14, 95% CI: 1.93 to 2.38; often/always, OR=4.73, 95% CI: 4.03 to 5.56), loneliness (sometimes, OR=2.97, 95% CI: 2.59 to 3.41; often/always, OR=8.35, 95% CI: 7.20 to 9.69), sadness (OR=2.51, 95% CI: 2.25 to 2.79) and physical fight (OR=1.29, 95% CI: 1.13 to 1.48) were positively associated with anxiety symptoms, while studying at vocational high school (OR=0.61, 95% CI: 0.49 to 0.75), coming from family with middle income (OR=0.76, 95% CI: 0.64 to 0.89), being physically active 3–7 days weekly (OR=0.85, 95% CI: 0.75 to 0.95) were negatively associated with anxiety symptoms.

**Conclusion** Anxiety symptoms prevailed among middle and high school students in China. A variety of factors, containing sociodemographic factors, lifestyle behaviours, mental health, academic performance and physical fight should be taken in consideration in addressing prevention and intervention of anxiety symptoms.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is a school-based study with a large sample size, a high response rate and a standardised procedure.
- ⇒ The questionnaire includes a wide range of factors, which might help us better understand how to prevent anxiety symptoms among adolescents.
- ⇒ The nature of cross-sectional study constrains establishment of the temporal relationship of associated factors with anxiety symptoms.
- ⇒ All data came from self-report. The indicated levels of anxiety may not always be in accordance with the appraisal of mental health professionals.

## INTRODUCTION

Anxiety disorders are the most common mental health worldwide. The estimated incident anxiety disorders case number increased from 31.1million in 1990 to 45.8million in 2019 globally, with corresponding prevalent cases increasing from 194.9 million to 301.4 million.<sup>1</sup> There was 7.3million incident anxiety disorders case in China (<https://vizhub.healthdata.org/gbd-results/>), approximately accounting for 15.9% of the global total. Incident rate of anxiety disorders reached a peak at age of 10–14 years during the whole life span, due to childhood abuse<sup>2</sup> and corporal punishment,<sup>3</sup> etc. Anxiety ranks as the ninth leading cause of disease and disability among adolescents of 15–19 years, and sixth for those aged 10–14 years worldwide.<sup>4</sup> Adolescents had a higher prevalence of anxiety symptoms than adults.<sup>5</sup> Anxiety is the painful feeling that people typically recognise as uneasiness, apprehension or

worry.<sup>6</sup> Long-term and untreated anxiety disorders were not only associated with chronic diseases, including hypertension,<sup>7,8</sup> myocardial infarction,<sup>9</sup> dyslipidaemia,<sup>9</sup> obesity,<sup>9</sup> diabetes,<sup>9</sup> temporomandibular myalgia and migraine,<sup>10</sup> but also with committing suicide.<sup>11</sup> The prevalence of anxiety disorders varied across the world.<sup>12</sup>

Numerous studies have described the patterns of anxiety symptoms among adolescents elsewhere. However, most studies focused on college students,<sup>13–15</sup> small sample size,<sup>16–19</sup> non-random sampling,<sup>20–24</sup> confined in specific cities.<sup>17–19</sup> The 2019 novel COVID-19 first outbreak in China, and was later declared a public health emergency of international concern by WHO in January 2020.<sup>25</sup> The outbreak of COVID-19 may increase anxiety and depression among the public.<sup>26,27</sup> Adolescents who got used to routine activities were particularly vulnerable to the psychological effects of COVID-19 pandemic and its associated infection control measures.<sup>28</sup> However, majority of those studies were conducted before 2020 or at the early stage of COVID-19 pandemic (ie, first half year of 2020).<sup>13,14</sup> In addition, the effect of COVID-19 pandemic on adolescent mental health is not in full consensus. While some studies indicated that COVID-19 pandemic might increase the prevalence of mental health (eg, anxiety symptoms and depression symptoms) among adolescents,<sup>29</sup> a nationally representative study of 12–18 years South Korean adolescents demonstrated that the prevalence of suicidal ideation decreased from 13.5% to 10.9% between 2019 and 2020, with suicidal attempts from 2.8% to 2.0%,<sup>30</sup> and a longitudinal study of 1952 Chinese middle and high school students documented that the differences in anxiety and depression symptoms between before and during COVID-19 pandemic were not statistically significant.<sup>31</sup> Furthermore, scarce studies pay attention to the association of dietary behaviours with anxiety symptoms among adolescents. Hence, the current study was designed to describe the prevalence and associated factors of anxiety symptoms among middle and high school students in Zhejiang Province, China.

## METHODS

### Survey design and participants

A multistage cluster sampling design was carried out. In stage one, 30 counties/districts were sampled at random from all 90 counties/districts. In stage two, 11 classes of middle school, 6 classes of academic high school and 6 classes of vocational high school were selected at random from each chosen county/district. In stage three, all students in every selected class were invited to participate in the study. Inclusion criteria included: (1) students in the selected class; (2) returning signed informed written consent and exclusion criteria was having serious health condition or illness that would prevent students from participating, including intellectual disability or language disorder.

### Sample size calculation

The sample size was calculated by using the formula:  $n = \frac{deff \times u^2 \times P \times (1 - P)}{d^2}$ . Means and 95% CI (two-sided for  $u = 1.96$ ) were determined; the prevalence of anxiety symptoms (10.4%) obtained in the China was used as a measure of probability ( $P$ );<sup>32</sup> the design effect ( $deff$ ) value was set at 4 and the relative error was:  $d = r \times 0.104$ ,  $r = 15\%$ . Based on these parameters, the sample size for each stratum was estimated to be 5883 subjects. Because there were four strata (area: urban and rural; gender: boy and girl), and assuming a potential non-response rate of 10%, the final sample size was calculated as 26 150.

### Procedure

A self-administered questionnaire, designed on surveys including Youth Risk Behaviour Survey (YRBS) and Global School-based Student Health Survey (GSHS), was used to collect the following information: demographic characteristics (including age, gender, parental education level, parental marital status and family income), life-style behaviours (cigarettes smoking, alcohol drinking, physical activity, dietary habits and insomnia), academic performance, mental health (loneliness, sadness, anxiety symptoms and depression symptoms) and physical fight. All field survey was implemented by well-trained staff with a standardised procedure. Students were asked to fill out a questionnaire in the classroom in the absence of their teachers, with a distance of at least one metre between students' seat. All surveyed students were advised, by trained staff, that the survey was anonymous, that there were no so-called 'correct' or 'incorrect' answers, that their answers were irrelevant to their academic performance and would be kept confidential, that the completed questionnaire was put into sealed box by students themselves, and that the questions should be answered honestly. The survey was conducted between April and June 2022.

### Patient and public involvement

Participants were healthy students and no patients were involved in the study. Students and their parents were not involved in the design and conduct of study. Due to an anonymous survey, our findings will be disseminated to Department of Health, not directly to participating students.

### Outcome variables

Anxiety symptoms were assessed using the Generalised Anxiety Disorder 7-item scale (GAD-7), a self-report scale evaluating anxiety symptoms during the past 2 weeks based on DSM-IV criteria. Each item is rated on a 4-point Likert-type scale ranging from 0 (not at all) to 3 (nearly every day). Total scores range from 0 to 21, with higher scores indicating greater probability of anxiety symptoms. A total score of 10 or more is considered indicative of anxiety symptoms.<sup>33,34</sup> In addition, the total scores for anxiety symptoms severity were 5–9 for mild, 10–14 for moderate and 15–21 for severe.<sup>33</sup> Previous studies indicated that the GAD-7 scale had good reliability and

validity.<sup>35</sup> Cronbach's alpha was between 0.90 and 0.92.<sup>33 36</sup> The GAD-7 scale has been widely utilised among adolescents in previous studies.<sup>32 37</sup>

### Main covariates

Covariates in the present study consisted of sociodemographic factors (birthdate, gender, region, types of school, parental education, parental marital status and family income), lifestyle behaviours (ie, cigarettes smoking, alcohol drinking, physical activity, dietary habit and insomnia), academic performance, mental health (ie, loneliness and sadness) and physical fight. Cigarettes smoking was defined as smoking cigarettes at least 1 day in the past 30 days. Alcohol drinking was defined as drinking alcohol at least 1 day in the past 30 days. Sadness was defined as ever experiencing feel sad or hopeless almost every day for 2 weeks or more in a row and stopped doing some usual activities in the past 12 months. Physical fight was defined as ever being involved in a physical fight at least once in the past 12 months.

### Statistical analysis

A weighting factor was applied at the student-level to adjust for non-response and for the varying probabilities of selection.<sup>38</sup> Continuous variables were presented as mean±SD. Categorical variables were presented as percent and 95% CI. Weighted prevalence was calculated using the PROC SURVEYFREQ procedure. To ascertain the associations of each correlating factor with anxiety symptoms, univariate and multivariable logistic regression analyses were utilised using the PROC SURVEYLOGISTIC procedure, to take into account the complex survey sampling methods. In univariate logistic regression, each variable was entered into a regression model. In multivariable logistic regression, all variables were entered simultaneously into model, and each OR was adjusted for all other variables. All these variables were reported to be associated with anxiety symptoms in previous papers.<sup>12 32 39–46</sup> All statistical analyses were conducted using SAS software V.9.4 (SAS Institute, Cary, North Carolina, USA). Statistical significance was determined as a two-sided *p* value<0.05.

## RESULTS

### Descriptive statistics

Overall, 28043 middle and high school students were invited to participate. Of whom 114 refused to participate and 859 were absent from school on the survey day, yielding a response rate of 96.5%. Owing to 51 incomplete questionnaires, 27019 eligible participants with a mean age of 15.7±1.7 years, comprising 13939 boys and 13080 girls, were included in the ultimate analyses.

Of the 27019 students, 35.3% came from urban areas; 51.8% were middle school students; 12.4% came from non-intact families; 55.2% of students' paternal educational level was middle school or below; 58.7% of students' maternal educational level was middle school or below; 5.5% of students came from low-income families;

55.0% of students reported being physically active≥3 days weekly; 30.5% of students reported having poor academic performance; 3.9% of students smoked cigarettes in the past 30 days; 16.0% of students drank alcohol in the past 30 days; 29.0% of students consumed fruits less than once daily; 8.0% of students consumed vegetables less than once daily; 10.2% of students consumed milk less than once daily; 72.3% of students never or occasionally suffered from insomnia; 13.1% of students often or always felt lonely and 13.7% of students reported ever engaging in physical fight in the past 12 months.

In comparison with students without anxiety symptoms, those suffering from anxiety symptoms were more inclined to be old (table 1), to be girls (62.2% vs 45.0%), to come from rural areas (68.9% vs 64.0%), to be from academic high school (28.9% vs 25.6%), to living in families with low or very low income (9.8% vs 4.8%), to have poor academic performance (39.6% vs 29.0%), to smoke cigarettes (6.5% vs 3.5%), to drink alcohol (24.4% vs 14.6%), to consume fruits less than once daily (38.1% vs 27.5%), to consume vegetables less than once daily (12.0% vs 7.3%), to consume milk less than once daily (13.2% vs 9.8%), to feel lonely often or always (47.8% vs 7.4%) or sad (49.5% vs 12.6%) and were less inclined to come from intact families (82.6% vs 88.4%), to be physically active. No significant difference was observed in parental education level by anxiety symptoms (*p*>0.05).

### Prevalence of anxiety symptoms

The overall prevalence (95% CI) of anxiety symptoms was 14.2% (13.4 to 15.0) (table 2), higher among girls (18.6%, 95% CI: 17.5 to 19.7) than boys (10.2%, 95% CI: 9.5 to 10.9) (*p*<0.001), higher among rural students (15.1%, 95% CI: 14.1 to 16.2) than those living in urban areas (12.5%, 95% CI: 11.6 to 13.4) (*p*<0.001). The prevalence (95% CI) among students aged≤13 years, 14–15 years and ≥16 years was 12.7% (11.4–14.1), 15.5% (14.1–16.8) and 13.9% (12.9–14.9), respectively. The prevalence (95% CI) among students attending middle school, academic high school and vocational high school was 14.4% (13.2–15.6), 15.7% (14.4–17.1) and 11.8% (10.4–13.2), respectively (*p*<0.001). In addition, the overall prevalence (95% CI) of anxiety symptoms with a positive threshold≥5 was 45.5% (44.1–46.7), and the prevalence (95% CI) of mild, moderate and severe anxiety symptoms were 31.3% (30.4–32.2), 9.2% (8.7–9.7) and 5.0% (4.6–5.4), respectively (additional file 1: online supplemental table S1).

### Logistic regression analysis

After adjusting for other variables included in the model, multivariable logistic analyses indicated that, compared with those aged≤13 years, the OR (95% CI) of anxiety symptoms for students aged 14–15 years and ≥16 years were 1.25 (1.09–1.44) and 1.32 (1.07–1.63), respectively (table 3). Girls had a 1.8 (OR=1.76, 95% CI: 1.58 to 1.96) times higher probability of anxiety symptoms than boys (*p*<0.001). Students living in rural areas were 1.1 times more likely to suffer from anxiety symptoms in





**Table 1** Participant characteristics by anxiety symptoms (n=27 019)

Characteristics	Total	Without anxiety symptoms	With anxiety symptoms	P value
	(n=27 019)	(n=23 274)	(n=3745)	
Age range (years)				0.008
≤13	5595 (22.3)	4909 (22.7)	686 (20.1)	
14–15	8579 (33.8)	7277 (33.3)	1302 (36.9)	
≥16	12 845 (43.9)	11 088 (44.0)	1757 (43.0)	
Gender				<0.001
Boys	13 939 (52.6)	12 521 (55.0)	1418 (37.8)	
Girls	13 080 (47.4)	10 753 (45.0)	2327 (62.2)	
Area				<0.001
Urban	10 796 (35.3)	9438 (36.0)	1358 (31.1)	
Rural	16 223 (64.7)	13 836 (64.0)	2387 (68.9)	
Types of school				0.001
Middle school	12 767 (51.8)	10 987 (51.7)	1780 (52.7)	
Academic high school	7378 (26.1)	6199 (25.6)	1179 (28.9)	
Vocational high school	6874 (22.1)	6088 (22.7)	786 (18.4)	
Parental marital status				<0.001
Married	23 530 (87.6)	20 457 (88.4)	3073 (82.6)	
Others	3489 (12.4)	2817 (11.6)	672 (17.4)	
Paternal education level				0.62
Middle school or below	14 947 (55.2)	12 869 (55.1)	2078 (55.8)	
High school	7176 (26.0)	6206 (26.1)	970 (25.2)	
College or above	4896 (18.8)	4199 (18.8)	697 (19.0)	
Maternal education level				0.40
Middle or below	15 985 (58.7)	13 758 (58.6)	2227 (59.3)	
High school	6383 (23.2)	5488 (23.2)	895 (23.6)	
College or above	4651 (18.1)	4028 (18.2)	623 (17.1)	
Family income				<0.001
Very low/low	1572 (5.5)	1189 (4.8)	383 (9.8)	
Middle	23 157 (85.6)	20 160 (86.6)	2997 (79.8)	
Very high/high	2290 (8.9)	1925 (8.6)	365 (10.4)	
Physical activity (day/week)				<0.001
0	5410 (19.9)	4429 (18.9)	981 (26.3)	
1–2	6821 (25.1)	5882 (25.1)	939 (25.1)	
3–7	14 788 (55.0)	12 963 (56.0)	1825 (48.6)	
Academic performance				<0.001
Excellent	5287 (19.6)	4680 (20.3)	607 (15.7)	
Middle	13 484 (49.9)	11 841 (50.7)	1643 (44.7)	
Poor	8248 (30.5)	6753 (29.0)	1495 (39.6)	
Cigarettes smoking	1115 (3.9)	860 (3.5)	255 (6.5)	<0.001
Alcohol drinking	4463 (16.0)	3527 (14.6)	936 (24.4)	<0.001
Fruits intake<1 time/day	7823 (29.0)	6407 (27.5)	1416 (38.1)	<0.001
Vegetables intake<1 time/day	2170 (8.0)	1713 (7.3)	457 (12.0)	<0.001
Milk intake<1 time/day	2690 (10.2)	2205 (9.8)	485 (13.2)	<0.001
Insomnia				<0.001
Never/occasional	19 591 (72.3)	18 284 (78.5)	1307 (34.5)	

Continued

**Table 1** Continued

Characteristics	Total	Without anxiety symptoms	With anxiety symptoms	P value
Sometimes	5376 (20.0)	4068 (17.5)	1308 (35.3)	
Often/always	2052 (7.7)	922 (4.0)	1130 (30.2)	
Loneliness				<0.001
Never/occasional	16899 (62.2)	16116 (69.1)	783 (19.9)	
Sometimes	6697 (24.7)	5494 (23.5)	1203 (32.3)	
Often/always	3423 (13.1)	1664 (7.4)	1759 (47.8)	
Sadness	4783 (17.8)	2947 (12.6)	1836 (49.5)	<0.001
Physical fight	3573 (13.7)	2846 (12.6)	727 (20.5)	<0.001

Number in brackets are weighted proportions.

comparison with their counterparts living in urban areas (OR=1.14, 95% CI: 1.01 to 1.29) ( $p=0.031$ ). Compared with students attending middle school, those attending vocational high school had lower probability of anxiety symptoms (OR=0.61, 95% CI: 0.49 to 0.75) ( $p<0.001$ ). Students from family with middle income was 0.8 times more likely to suffer from anxiety symptoms in comparison to those from families with very low or low income (OR=0.76, 95% CI: 0.64 to 0.89) ( $p<0.001$ ). Compared with students who were physically inactive within the past 7 days, students who were physically active on 3–7 days had lower probability of anxiety symptoms (OR=0.85, 95% CI: 0.75 to 0.95) ( $p=0.007$ ). Students with poor academic performance were 1.2 times more likely to suffer from anxiety symptoms in comparison to their counterparts with excellent academic performance (OR=1.20, 95% CI:

1.03 to 1.41) ( $p=0.02$ ). Alcohol drinkers were 1.2 times more likely to suffer from anxiety symptoms in comparison to non-drinkers (OR=1.15, 95% CI: 1.01 to 1.30) ( $p=0.031$ ). Students consuming fruits less than once daily was 1.3 times more likely to suffer from anxiety symptoms in comparison to those consuming fruits at least once daily (OR=1.31, 95% CI: 1.19 to 1.45) ( $p<0.001$ ), and the corresponding ORs (95% CI) for consuming vegetables and consuming milk were 1.32 (1.10–1.57) ( $p=0.003$ ) and 1.11 (0.94–1.30) ( $p=0.208$ ), respectively. Compared with students suffering from insomnia never or occasionally, those suffering sometimes and often or always were 2.1 times (OR=2.14, 95% CI: 1.93 to 2.38) and 4.7 (OR=4.73, 95% CI: 4.03 to 5.56) times, respectively, more likely to experience anxiety symptoms ( $p<0.001$ ). Students who sometimes and often or always felt lonely were 3.0 times (OR=2.97, 95% CI: 2.59 to 3.41) and 8.4 times (OR=8.35, 95% CI: 7.20 to 9.69), respectively, more likely to experience anxiety symptoms than those never or occasionally felt lonely ( $p<0.001$ ). Students who ever felt sad had a 2.5 times higher odds of anxiety symptoms than those without sadness (OR=2.51, 95% CI: 2.25 to 2.79) ( $p<0.001$ ). Students being involved in physical fight had a 1.3 times higher odds of anxiety symptoms than those without physical fight (OR=1.29, 95% CI: 1.13 to 1.48) ( $p<0.001$ ).

**Table 2** Weighted prevalence of anxiety symptoms by characteristics

	Prevalence (95% CI)	P value
Age (years)		0.008
≤13	12.7 (11.4 to 14.1)	
14–15	15.5 (14.1 to 16.8)	
≥16	13.9 (12.9 to 14.9)	
Gender		<0.001
Boys	10.2 (9.5 to 10.9)	
Girls	18.6 (17.5 to 19.7)	
Area		<0.001
Urban	12.5 (11.6 to 13.4)	
Rural	15.1 (14.1 to 16.2)	
Types of school		0.001
Middle school	14.4 (13.2 to 15.6)	
Academic high school	15.7 (14.4 to 17.1)	
Vocational high school	11.8 (10.4 to 13.2)	
Prevalence was based on the weighted data.		

## DISCUSSION

In this provincially representative study of middle and high school students from China, 14.2% of middle and high school students have anxiety symptoms, and socio-demographic factors (age, gender, living area and family income), lifestyle behaviours (alcohol drinking, physical activity, fruits intake, vegetables intake and insomnia), mental health (loneliness and sadness), academic performance and physical fight were associated with anxiety symptoms among adolescents.

### Prevalence of anxiety symptoms

An updated meta-analysis of 604491 primary and secondary school students or children and adolescents $\leq 18$

**Table 3** Crude and adjusted ORs of factors associated with anxiety symptoms among students

Variables	Crude ORs	P value	Adjusted ORs	P value
Age range (ref: ≤13 years)				
14–15	1.26 (1.10–1.44)	0.001	1.25 (1.09–1.44)	0.002
≥16	1.11 (0.96–1.29)	0.16	1.32 (1.07–1.63)	0.011
Girls (ref: boys)	2.01 (1.85–2.18)	<0.001	1.76 (1.58–1.96)	<0.001
Rural (ref: urban)	1.25 (1.11–1.41)	<0.001	1.14 (1.01–1.29)	0.031
Types of school (ref: middle school)				
Academic high school	1.11 (0.96–1.28)	0.147	0.96 (0.79–1.17)	0.678
Vocational high school	0.80 (0.68–0.94)	0.007	0.61 (0.49–0.75)	<0.001
Parental marital status (ref: married)				
Others	1.60 (1.40–1.84)	<0.001	1.10 (0.94–1.29)	0.231
Paternal education level (ref: middle or below)				
High school	0.96 (0.87–1.05)	0.325	1.00 (0.89–1.13)	0.974
College or above	1.00 (0.89–1.13)	0.974	1.07 (0.90–1.27)	0.466
Maternal education level (ref: middle or below)				
High school	1.00 (0.91–1.11)	0.928	1.02 (0.90–1.16)	0.711
College or above	0.93 (0.82–1.05)	0.226	1.01 (0.85–1.20)	0.941
Family income (ref: very low/low)				
Middle	0.45 (0.39–0.52)	<0.001	0.76 (0.64–0.89)	<0.001
Very high/high	0.59 (0.49–0.72)	<0.001	0.95 (0.76–1.18)	0.625
Physical activity (ref: none)				
1–2 day/week	0.71 (0.63–0.80)	<0.001	0.87 (0.75–1.01)	0.075
3–7 day/week	0.62 (0.56–0.69)	<0.001	0.85 (0.75–0.95)	0.007
Academic performance (ref: excellent)				
Middle	1.14 (1.02–1.27)	0.02	1.01 (0.88–1.16)	0.866
Poor	1.76 (1.55–2.01)	<0.001	1.20 (1.03–1.41)	0.02
Cigarettes smoking	1.92 (1.59–2.32)	<0.001	1.12 (0.92–1.37)	0.261
Alcohol drinking	1.89 (1.69–2.11)	<0.001	1.15 (1.01–1.30)	0.031
Fruits intake<1 time/day	1.62 (1.48–1.78)	<0.001	1.31 (1.19–1.45)	<0.001
Vegetables intake<1 time/day	1.72 (1.49–1.98)	<0.001	1.32 (1.10–1.57)	0.003
Milk intake<1 time/day	1.39 (1.24–1.57)	<0.001	1.11 (0.94–1.30)	0.208
Insomnia (ref: never/occasional)				
Sometimes	4.60 (4.18–5.07)	<0.001	2.14 (1.93–2.38)	<0.001
Often/always	17.2 (15.2–19.6)	<0.001	4.73 (4.03–5.56)	<0.001
Loneliness (ref: never/occasional)				<0.001
Sometimes	4.78 (4.18–5.46)	<0.001	2.97 (2.59–3.41)	<0.001
Often/always	22.4 (19.6–25.7)	<0.001	8.35 (7.20–9.69)	<0.001
Sadness	6.79 (6.23–7.40)	<0.001	2.51 (2.25–2.79)	<0.001
Physical fight	1.79 (1.60–2.00)	<0.001	1.29 (1.13–1.48)	<0.001

Adjusted ORs are adjusted for all other covariates in the model.

years included 27 studies published between January 2020 and October 2022, with GAD-7 scale as screening tool and score≥5 as a positive threshold of anxiety symptoms, and the results of which documented that the prevalence of anxiety symptoms was 35%.<sup>39</sup> The prevalence of anxiety symptoms with a positive threshold≥5 in our study

was 45.5%, higher than the results of the aforementioned meta-analysis, implying that the prevalence of anxiety symptoms among adolescents may be underestimated worldwide. One study of 50 361 Chinese primary and secondary school students from five Provinces conducted between 2008 and 2015 observed that the prevalence

of anxiety was 7%.<sup>40</sup> Another survey of 8079 Chinese junior and senior high school students from 21 Provinces conducted in March 2020 indicated that the prevalence of moderate and severe anxiety symptoms (ie, the score of GAD-7 not less than 10) was 10.4%.<sup>32</sup> The prevalence of anxiety symptoms in the present study was higher than the results of the two studies above. One possible explanation was variation of geographic regions and survey year. Another explanation was long-term of COVID-19 epidemic might increase the prevalence of anxiety symptoms. A longitudinal study of 164101 Chinese college students revealed that the prevalence of probable acute stress symptoms decreased, while the prevalence of anxiety and depressive symptoms increased from the COVID-19 outbreak to the COVID-19 remission stage.<sup>29</sup> Kastner and colleagues surveyed 840 8- to 18-year-old German children and adolescents, and found that they continued to exhibit low health-related quality of life 2 years after the outbreak of the COVID-19 pandemic.<sup>47</sup> Hence, the present study sheds light on the importance of strengthening surveillance of anxiety symptoms among adolescents in postepidemic era of COVID-19 and observing the long-term effect of pandemic of COVID-19 on adolescent mental health. In line with previous studies,<sup>48 49</sup> girls had a higher prevalence of anxiety symptoms than boys.

### Associated factors of anxiety symptoms

Association of sociodemographic factors with anxiety symptoms in the present study was consistent with most previous studies. Older age,<sup>32</sup> living in rural areas,<sup>41</sup> coming from family with low income,<sup>40 42</sup> were positively associated with anxiety symptoms, and there was no association between maternal education level and adolescent anxiety symptoms.<sup>50</sup> In align with previous studies,<sup>40 43</sup> poor academic performance was positively related to anxiety symptoms. Zhou and colleagues found students attending high school had higher odds of anxiety symptoms than those attending middle school during the outbreak of COVID-19.<sup>32</sup> However, they failed to differentiate academic and vocational high school. Students attending vocational high school had lower odds of anxiety symptoms than those attending middle school after adjusting for all other covariates in the present study.

An inverse correlation of high-intensity activity with anxiety symptoms was documented in the findings of Korea Youth Health Behavior Survey 2021.<sup>49</sup> Additionally, a school-based survey of 11110 adolescents from 10 European countries demonstrated that frequent physical activity was found to independently contribute to lower levels of anxiety symptoms,<sup>51</sup> similar with the present results. Our study extended evidence that physical activity may be an effective approach to addressing anxiety symptoms among adolescents. A cross-sectional study of 1074 college students indicated that frequent consumption of alcohol was significantly associated with anxiety symptoms,<sup>44</sup> consistent with the present study. A study of

988 Brazilian adolescents observed a positive association of cigarettes smoking with anxiety.<sup>45</sup> Nevertheless, null statistical significance was found in the present study. Dietary guidelines for Chinese school children 2022 recommended that school children should intake enough fruits and vegetables and at least 300 g dairy products daily.<sup>52</sup> The current study indicated that the percentage of consuming fruits<1 time/day, consuming vegetables<1 time/day, consuming milk<1 time/day was 29%, 8% and 10.2%, respectively. An accelerating number of studies revealed that diet and nutrition are crucial not only for physiology and body composition, but also impose vital effects on mood and mental well-being.<sup>53</sup> A healthy dietary pattern might promote mental health by means of anti-inflammatory, antioxidant, neurogenesis, microbiome- and immune-modifying mechanisms, as well as by means of epigenetic modifications.<sup>54</sup> Noteworthy, infrequent intake of healthy foods, including fruits and vegetables was positively associated with anxiety symptoms among middle and high school students in our study, suggesting dietary habit improvement should be taken in consideration in addressing the issue of anxiety symptoms among adolescents.

A cohort study of 25130 general adults from the Norwegian county of Nord-Trøndelag observed that chronic insomnia was a risk factor for the development of anxiety disorders,<sup>46</sup> consistent with the current study. Hence, students suffering from insomnia should be taught the skills of improving sleep quality, including getting on a sleep schedule and avoiding disruptions before sleep (eg, consuming coffee and alcohol, and exposure to blue light screens, etc). Previous study documented that 7.0% of global DALYs caused by anxiety disorders can be attributed to bullying victimisation in 2019.<sup>12</sup> Physical fight was positively associated with anxiety symptoms in the present study, implying that school bullying prevention should be a crucial component of intervention for adolescents with anxiety symptoms.

The findings of the current study are of potential clinical and public health importance. First, though WHO announced that COVID-19 pandemic no longer constitutes a public health emergency of international concern in May 2023.<sup>55</sup> Considering the unpredictable risk for new variants of COVID-19, more comprehensive and effective efforts are needed to address these issues in China, including strengthening surveillance of anxiety symptoms and providing professional aid for students with anxiety symptoms. Second, a broad range of correlates, including socio-demographic factors, lifestyle behaviours, academic performance, mental health and physical fight might be integrated into intervention measures for individuals with anxiety symptoms.

A strength of this study is large representative samples that can be generalised to all of the middle and high school students in Zhejiang. Several



limitations need to be mentioned. First, the nature of cross-sectional study constrains establishment of the temporal relationship of associated factors with anxiety symptoms. Second, all data came from self-report. The indicated levels of anxiety may not always be in accordance with the appraisal of mental health professionals. Large-scale longitudinal studies are needed to track the effect of COVID-19 pandemic on physical and mental health, and to establish the temporal relationship of influencing factors with adolescent anxiety disorders in the future.

## CONCLUSIONS

Our findings might provide insights on prevention and intervention of adolescent anxiety symptoms, and shed light on the associated factors of anxiety symptoms among middle and high school students in Zhejiang China. We found that anxiety symptoms remain prevailing among adolescents after 2 years of the COVID-19 pandemic. A variety of correlates, including sociodemographic factors, lifestyle behaviours, mental health and physical health should be taken in consideration in solving adolescent anxiety symptoms.

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Table S1 Weighted prevalence of mild, moderate, and severe anxiety symptoms by characteristics

Characteristics	Mild		Moderate		Severe	
	Prevalence	<i>P</i> value	Prevalence	<i>P</i> value	Prevalence	<i>P</i> value
Age (years)		<0.001		0.004		0.01
≤13	26.8 (25.1-28.4)		7.7 (6.8-8.7)		5.0 (4.2-5.7)	
14-15	30.1 (28.6-31.7)		9.8 (8.9-10.6)		5.7 (5.0-6.4)	
≥16	34.4 (33.3-35.5)		9.4 (8.7-10.1)		4.5 (4.0-5.0)	
Gender		<0.001		<0.001		<0.001
Boys	27.8 (26.8-28.9)		6.8 (6.3-7.3)		3.4 (3.0-3.8)	
Girls	35.0 (33.9-36.2)		11.8 (11.1-12.6)		6.8 (6.2-7.4)	
Area		0.97		0.005		<0.001
Urban	31.3 (29.6-33.0)		8.3 (7.7-9.0)		4.2 (3.6-4.7)	
Rural	31.2 (30.0-32.4)		9.7 (9.0-10.3)		5.4 (4.9-6.0)	
Types of school		<0.001		<0.001		0.008
Middle school	28.5 (27.2-29.8)		9.0 (8.3-9.7)		5.4 (4.8-6.0)	
Academic high school	37.3 (36.0-38.6)		10.5 (9.6-11.5)		5.2 (4.5-5.9)	
Vocational high school	30.6 (28.9-32.4)		8.0 (7.0-8.9)		3.8 (3.1-4.6)	

Prevalence was based on the weighted data. Number in brackets was 95% confidence Interval