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Aggression and patterns of co-occurrence mental health problems in Chinese adolescents: a latent class analysis

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Abstract

Background Mental health is an important aspect of adolescents' development and well-being. Mental health problems, such as depression, anxiety, non-suicidal self-injury, suicide ideation, and suicide attempt, are recognized to be interconnected and to occur often. Research has found that aggression is connected to a variety of mental health problems. However, there's limited knowledge about the patterns of how depression, anxiety, non-suicidal self-injury, suicide ideation, and suicide attempt co-occur, and only few studies describe their association with aggression and sex differences.

Methods A cross-sectional study that involved 18,555 Chinese adolescents was performed to explore the mental health latent classes and the relationship with aggression.

Results The results showed four latent classes of mental health problems: low-symptom class (70.8%), self-harm class (9.1%), emotional symptom class (13.4%), and high-symptom class (6.7%). A significant co-occurrence between depression, anxiety, non-suicidal self-injury, suicide ideation, and suicide attempt was found in the high-symptom class. Notably, higher levels of adolescent aggression were associated with comorbid moderate to high mental health problems. Similar four latent classes and associations were found across sexes.

Conclusions The present study emphasized the heterogeneity of mental health problems and revealed their co-occurrence patterns. Aggression levels are associated with the latent classes in adolescents, with the most pronounced association observed in the high-symptom class. Preventing aggression could contribute to reducing the severity and co-occurring patterns of mental health problems among adolescents.

Keywords Mental health problems, Aggression, Person-centered approach, Adolescents

Background

Aggression is characterized as intentional behavior designed to inflict psychological or physical damage on others or objects [3]. Aggression can be a normal and adaptive response in certain situations, such as self-defense or protecting others. However, excessive or inappropriate human aggression is considered a life-threatening pathological behavior, which is linked with a variety of long-term consequences, including mental health issues, socioeconomic challenges, and suicide [14, 16, 19]. Aggression is a global concern that increases considerably through adolescence [14]. Aggression and its subsequent consequences result in an increased burden on the influenced adolescents, their families, educators, peers, as well as society. Moreover, adolescent aggression seldom manifests independently and is associated with a series of mental

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health problems. For instance, depressed adolescents with higher levels of aggression showed more severe symptoms of NSSI, and adolescents who display aggression are more prone to experiencing mental health problems [64].

Mental health represents a significant public health concern and is crucial for adolescents' overall health. Moreover, it is associated with a range of long-term outcomes, such as increased risk of substance abuse, impaired cognitive functioning, decreased productivity, social isolation, and even suicide [20, 49, 61]. Due to the significant and rapid changes in biological, psychological, cognitive, and social as well as the numerous challenges confronted by adolescents, they are more susceptible to suffer from mental health issues [8]. A comprehensive review revealed that the lifetime occurrence of self-harm among adolescents was found to be 16.9% [29]. Similarly, around 20% of adolescents experience anxiety or depressive disorders before going to college [32]. Recent study showed that the prevalence of depressive, anxiety among Chinese adolescents were 25.6% and 26.9%, respectively [65]. Mental health problems can interfere with the critical developmental processes of adolescents, including the development of identity and skills, adapting to physical and social transformations, and establishing relationships with peers or parents [32].

Moreover, relevant research provides strong evidence to suggest that these mental health problems frequently co-occur [2, 48]. According to a multitude of research reports, as many as 60% of adolescents experiencing mental health problems are not merely confronting a single mental health issue, but rather, are battling a variety of mental health disorders [22]. Research has shown that in clinical samples, the co-occurrence rates of depression and anxiety can reach as high as 75% [54]. Additionally, the rates of comorbid depression and anxiety during adolescence were significantly higher, with a worse prognosis for comorbidity than either condition alone [23, 42]. Research has also indicated that non-suicidal self-injury (NSSI), suicide ideation (SI), and suicide attempts (SA) are common and frequently co-occurring [57]. Although depression, anxiety, NSSI, SI, and SA may initially appear to be distinct, numerous studies have shown that they are highly comorbid, even above and beyond the co-occurrence of anxiety and depression [7, 18, 51]. These findings support the underlying latent general structure of mental health problems. Understanding the latent organization of comorbid disorders is crucial as it could shed more light on the common etiology of mental health problems and might elucidate the disparities in treatment outcomes.

Research conducted over the past decade on the structure of comorbid disorders in adolescents has predominantly utilized a variable-centered approach. However, it may neglect the individual variations and the complex interplay of multiple disorders within a single individual. Distinct from variable-centered approaches, person-centered approaches like latent class analysis (LCA) enable the identification of subgroups with similar co-occurring patterns of mental health problems based on symptom presentation. However, to our knowledge, LCA has rarely been applied to understand the heterogeneity and complexity in adolescents' depression, anxiety, NSSI, SI, and SA. Additionally, the application of LCA to explore the association between aggression and these mental health problems is also limited. For example, [48] identified four latent classes based on depression, anxiety, NSSI, and SI for cisgender males and females, and two latent classes for gender minority participants among college students exposed to sexual assault, which reflected the spectrum of mental health problems co-occurrence risk from low to high. Ezpeleta et al. [24, 25] and colleagues identified three latent class group of irritability and oppositional, depression, and anxiety, and four groups of irritability, defiant, and obsessive-compulsive problems. However, no studies have examined their co-occurrence with SA, which is also a crucial mental health symptom and a robust predictor of potential future suicide risk [39, 53]. Given the increase in mental health problems among students during adolescence and their heterogeneity, it appears necessary and beneficial to use a person-centered approach to investigate patterns of the co-occurrence of a wider range of relative problems to provide information for early interventions in at-risk groups [28, 30].

Aggressive behavior is not only one of the manifestations of mental health problems, but can also exacerbate the severity of mental health problems. Therefore, exploring the relationship between aggression and mental health problems is essential for a comprehensive understanding of adolescent mental health. Previous studies have shown that aggression is multi-final as it is nearly concurrently and prospectively associated with all other mental health problems during adolescence, including depression, anxiety, NSSI, SI, and SA [14, 16, 19]. Although studies suggest that aggression could be a significant transdiagnostic factor across mental health problems, most studies have focused on its effect on a single mental health problem [15, 64]. This approach provides a limited understanding of the patterns of co-occurring mental health issues in adolescents. Therefore, identifying the patterns of mental health problems and understanding their relationship with aggression is essential.

Furthermore, sex has been demonstrated to be linked with the distribution and prevalence of aggression and mental health problems and is critical in interpreting the

relationship between aggression and mental health problems [10]. Indeed, it's observed that males tend to exhibit higher levels of aggression, while females are more prone to attempt suicide and experience stress-related mental disorders [56, 61]. In addition, Commisso and colleagues have indicated that male adolescents are more likely to present with comorbid mental health problems [17]. Given the varied evidence on sex differences in aggression and mental health problems, further research is needed to better understand the sex differences in mental health patterns and the association with aggression.

The present study aimed to (1) identify different classes of mental health problems (including depression, anxiety, NSSI, SI, and SA) in Chinese adolescents, and (2) investigate associations between aggression and each of the identified classes of mental health problems, and (3) the sex differences between aggression and LCA of mental health problems was investigated considering the sex differences between aggression and mental health problems.

Method

Study design and participants

Data was collected in China in April 2021. Participants were randomly sampled through a multistage, stratified approach (Fig. 1). Five provinces were selected as the representative provinces of various regions: Jiangsu (eastern), Guangdong (southern), Yunnan (western), Gansu (northern), and Hubei (central). Further information on multistage cluster sampling can be found in our previous work [52]. Participants provided informed written consent, and those aged < 18 also obtained written parental permission. The Ethics Committee of Tongji Medical College at Huazhong University of Science and Technology granted approval for this study.

Measures

Mental health problems

The PHQ-9 and GAD-7 self-rated modules were used to assess depression and anxiety symptoms in adolescents, respectively. These tools evaluate the frequency of symptoms over the past two weeks on a scale from 0 (not at all) to 3 (nearly every day) [35, 55]. The total score of the PHQ-9 ranged from 0 to 27 and the GAD-7 ranged from 0 to 21. The higher total scores indicate more severe symptoms of depression or anxiety. Both scores ≥ 10 were used as criteria for meeting the clinical diagnosis of depression and anxiety [1, 40]. In this study, the internal consistency reliability, measured by Cronbach's alpha, was 0.91 for the PHQ-9 and 0.94 for the GAD-7.

The Chinese version of the Functional Assessment of Self-Mutilation (CH-FASM) was used to evaluate adolescents' NSSI. This checklist assesses the methods, frequencies, and purposes of self-reported NSSI over the previous year [26]. CH-FASM shows eight distinct types of NSSI. Here are the details of the associated questions: Have you ever engaged in NSSI behaviors such as hit/pulled/headbutted/pinched/scratched or bitten/burn/cut yourself? For individuals who acknowledged participating in NSSI in the past year, an examination of the frequency of these behaviors was conducted. In this research, NSSI was categorized into two groups for statistical analysis: those who engaged in NSSI five or more times (NSSI), and those who did so less than five times (non-NSSI) [11, 60]. Cronbach's α for NSSI in this study was 0.84.

Past year SI was measured by the question: "Have you ever had thoughts of committing suicide?"; SA was measured by the question: "Have you ever tried to commit suicide?" Four options were provided: (1) None at all; (2) once; (3) 2–3 times; (4) ≥ 4 times [36, 58]. If the students answered "once" to "≥ 4 times", they were then defined as suicide ideators or attempters, otherwise non-suicide ideators or attempters.

Aggression

The Chinese version of the Buss and Warren's Aggression Questionnaire (BWAQ) was utilized to evaluate aggression among adolescents [44]. The BWAQ, which is rated on a 5-point Likert scale, comprises 34 items across five dimensions. These dimensions include physical, verbal, and indirect aggression, anger, and hostility. Initially, raw scores were computed for the total and five subscales. Higher scores correspond to increased levels of overall aggression and its five subtypes. Participants were categorized into two classes based on T-score: aggression (≥ 56T), and non-aggression (< 56T) [12, 33]. BWAQ has been demonstrated reliable consistency among Chinese [37, 38]. The Cronbach's α values for the total and the five subscales were as follows: 0.92, 0.78, 0.64, 0.75, 0.80, and 0.68.

Demographic variables

Adolescents provided information on various aspects including their age, residence (urban or rural), sex (males or females), grade (7th to 12th), only child (yes or no), family type (Nuclear family or Others), parents' education level (Less than primary school, Junior school, Senior school, College or above), mother's education level (Less than primary school, Junior school, Senior school, College or above), and monthly family income in CNY (~ 999, 1000 ~ 1999, 2000 ~ 3999, 4000 ~ 5999, 6000 ~ 7999, 8000~).

Analysis

LCA was used to categorize individuals into distinct groups based on depression, anxiety, NSSI, SI, and SA. Analyses were carried out separately for males and

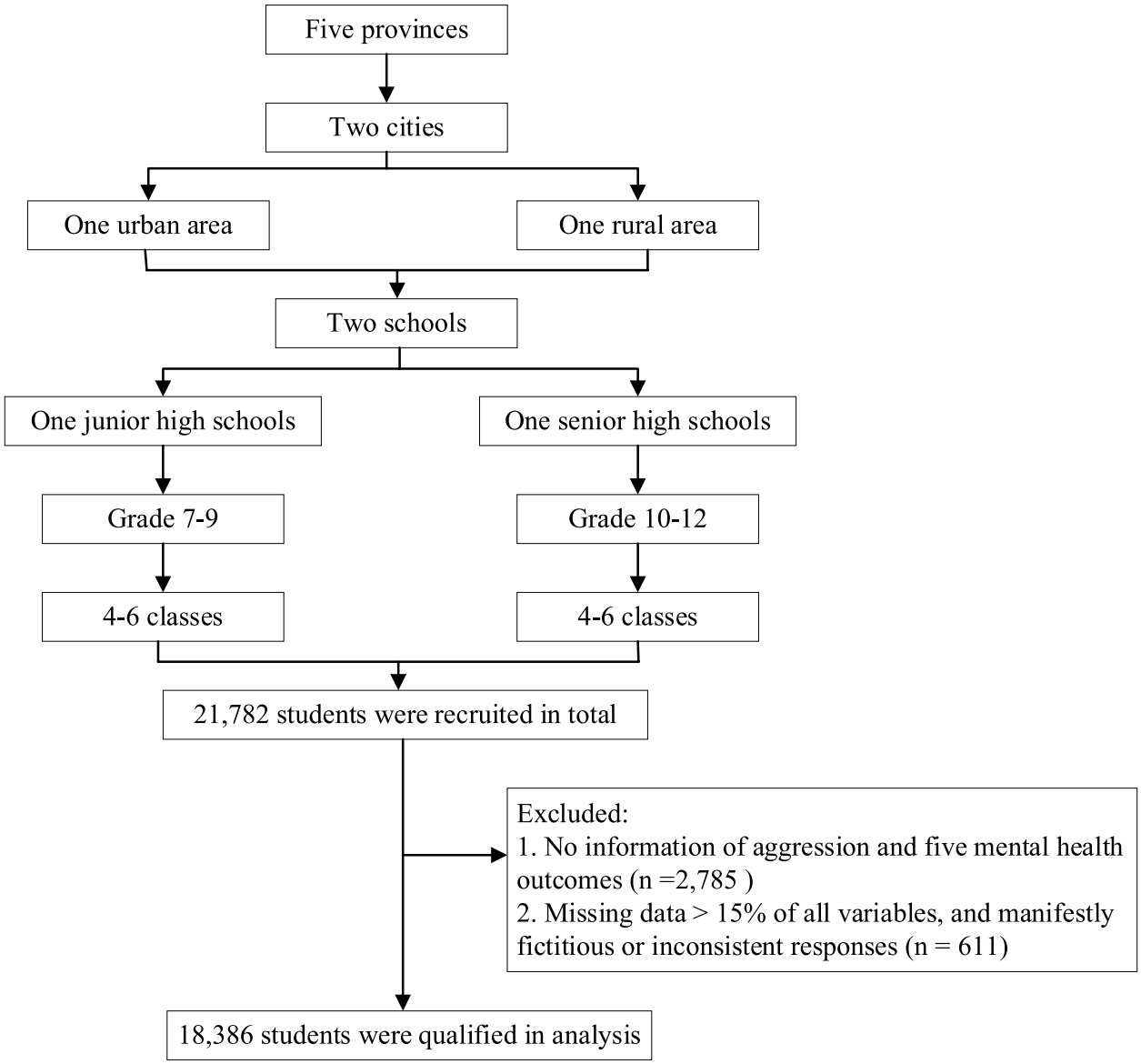

Fig. 1 The process for multi-stage cluster sampling and study participants selection

females, to investigate potential differences in mental health issues based on sex. Each participant is placed in the class where their likelihood of belonging is maximized, known as latent classes, which represent the most common and distinct developmental patterns. A range of latent class models was computed to identify the suitable number of classes that best represent the subgroups of mental health problems. This process started with a two-class model and progressively included models with an increasing number of classes. The selection of the optimal model relied on several suggested indices. These included the Akaike information criterion (AIC), Bayesian information criterion (BIC), adjusted BIC (aBIC), entropy, and two types of likelihood ratio tests: the Lo-Mendell-Rubin adjusted (LMR) and the bootstrapped (BLRT) [43, 46]. Entropy was utilized to assess the accuracy of the classification. It varies from 0 to 1, and an entropy value of 0.8 suggests that the classification's accuracy exceeded 90% [41]. A lower value of AIC, BIC, and aBIC, along with a higher entropy, represents a better model fit. LMR and BLRT were employed for comparing models with K and K-1 classes. If the p values for LMR and BLRT were significant, it suggested that the model with K classes had a superior fit compared to the model with K-1 classes [43]. As these fit indices did not work equally well in all modeling conditions and were not

always consistent, we considered statistical and substantive significance in establishing the number of categories [43, 46]. The multinomial logistic regression models were employed to examine the links between aggression and the latent classes of mental health problems. Due to the significant interaction between aggression and sex, stratified analyses were conducted. Analyses were conducted using SPSS (version 26.0) and Mplus (version 8.7). Significant p-value less than 0.05 (two-tailed).

Results

Demographic characteristics

Among 21,782 students who returned the questionnaire and provided consent forms, 2,785 were excluded for not responding to aggression and five mental health problems, 611 were excluded for missing data exceeding 15% in the questionnaire, and clearly fabricated or inconsistent responses, such as contradictory answers. Finally, 18,386 students [8,994 (48.9%) males; 9,392 (51.1%) females] were eligible for data analysis, and the response rate was 84.4%. The participants had an average age of 15.3 ± 1.88 years. The proportions for depression, anxiety, NSSI, SI, and SA in the total sample were 19.1%, 13.6%, 25.9%, 22.4%, and 4.8% respectively.

Table 1 contains the demographic details of the students. Overall, 26.4% of participants self-reported aggression. Furthermore, the highest prevalence of aggression was observed in the high-symptom class, with rates of 71.8%, compared to rates of 14.6% in low-symptom class, 31.3% in the self-harm class, and 55.2% in high-symptom class ($p < .001$). In addition, sex, age, grade, residence, family type, father's education level, mother's education level, monthly family income significantly different among the four latent classes (all $p < .001$). The results of mental health problems and latent classes stratified by sex are displayed in Table S1.

Patterns of mental health problems

Table 2 displays the statistics for the fit of the LCA model. While the entropy suggested a preference for a 3-class model, a detailed review of the 3- and 4-class models revealed that both BIC and BLRT, along with theoretical considerations, supported the selection of a 4-class model. Figure S1 illustrates the structure of the 4-class solution. First, two classes were identified: low-symptom class, comprising 12,361 (70.8%) of the students, who had low likelihoods of endorsing each outcome, and high-symptom class (1,378, 6.7%), who exhibited moderate to high probabilities of co-occurrence of depression, anxiety, NSSI, SI, and SA (Table 3). Additionally, two classes with intermediate risk were identified: self-harm class, and emotional symptom class. The self-harm class included 2,085 students (9.1%) who exhibited low symptoms of depression, anxiety, and SA but exhibited moderate NSSI and high SI. The emotional symptom class (2,562, 13.4%) was characterized by high depression and moderate anxiety. The four-class model was also considered to be the optimal model for both males and females (Table S2). Figure 2 illustrates the estimated conditional probabilities for endorsing any of the five mental health problems for the four-class LCA models for males and females.

Associations of aggression with mental health problems classes

The multinomial logistic regressions were performed to investigate the link between aggression and latent class memberships. Factors such as sex, grade, residence, only child, family type, parents' education level, and family income were considered as control variables in the analysis (Table 5). Results suggest that aggression was significantly associated with class memberships. Especially, students exhibiting higher levels of aggression had a greater likelihood of being classified into the self-harm class (OR = 2.71, 95% CI 2.44–3.02), emotional symptom class (OR = 6.87, 95% CI 6.26–7.55), and high-symptom class (OR = 15.04, 95% CI 13.21–17.13) rather than the low-symptom class. The results indicated that, compared to low-symptom class, students with higher aggression level were over 15 times more likely to be in the high-symptom class.

Interactions between aggression and sex were significant (Table 4). Table 5 displays a sex-specific association between aggression and latent class membership. For both males and females, aggression level was positively associated with class membership. Compared to the low-symptom class, males with higher levels of aggression exhibited a significantly increased likelihood of belonging to the self-harm class (OR = 2.44, 95% CI: 2.07–2.87), emotional symptom class (OR = 6.95, 95% CI: 6.05–7.97), and high-symptom class (OR = 14.16, 95% CI: 11.34–17.68). Similarly, among girls, those with a higher level of aggression exhibited significantly higher odds of being classified into the self-harm class (OR = 2.95, 95% CI: 2.56–3.39), emotional symptom class (OR = 6.82, 95% CI: 5.99–7.76), and high-symptom class (OR = 15.66, 95% CI: 13.33–18.41).

Discussion

Mental health is a critical aspect of adolescents' development and well-being. It is well-established that aggression can act as a prominent social stressor for adolescents and may contribute to the development of adverse outcomes. However, earlier studies in this field have predominantly utilized variable-centered methods, which may not be adequate to understand the co-occurrence

Table 1 Sample characteristics stratified by four identified classes [n (%)]

Characteristic	Total (*N* = 18,386)	Latent classes				Statistics	
		Low-symptom (*n* = 12361)	Self-harm (*n* = 2085)	Emotional symptom (*n* = 2562)	High-symptom (*n* = 1378)	χ^2 /t	*p*
Sex						351.14	< 0.001
Male	8994 (48.9)	6590 (53.3)	833 (40.0)	1137 (44.4)	434 (31.5)		
Females	9392 (51.1)	5771 (46.7)	1252 (60.0)	1425 (55.6)	944 (68.5)		
Age (mean, SD)	15.3 (1.88)	15.3 (1.91)	15.1 (1.76)	15.8 (1.81)	15.2 (1.73)	75.86	< 0.001
Grade						141.59	< 0.001
7–9	9441 (51.3)	6489 (52.5)	1166 (55.9)	1045 (40.8)	741 (53.8)		
10–12	8945 (48.7)	5872 (47.5)	919 (44.1)	1517 (59.2)	637 (46.2)		
Residence						286.46	< 0.001
Urban	9407 (51.2)	6728 (54.4)	1119 (53.7)	952 (37.2)	608 (44.1)		
Rural	8979 (48.8)	5633 (45.6)	966 (46.3)	1610 (62.8)	770 (55.9)		
Only child						4.96	0.175
No	13,367 (72.7)	9000 (72.8)	1476 (70.8)	1885 (73.6)	1006 (73.0)		
Yes	5019 (27.3)	3361 (27.2)	609 (29.2)	677 (26.4)	372 (27.0)		
Family type						166.60	< 0.001
Nuclear family	15,584 (84.8)	10,740 (86.9)	1746 (83.7)	2043 (79.7)	1055 (76.6)		
Others	2802 (15.2)	1621 (13.1)	339 (16.3)	519 (20.3)	323 (23.4)		
Father's education level						138.10	< 0.001
Less than primary school	1956 (10.6)	1227 (9.9)	167 (8.0)	401 (15.7)	161 (11.7)		
Junior school	6721 (36.6)	4496 (6.4)	733 (35.2)	1010 (39.4)	482 (35.0)		
Senior school	5279 (28.7)	3628 (29.4)	599 (28.7)	655 (25.6)	397 (28.8)		
College or above	4430 (24.1)	3010 (24.4)	586 (28.1)	496 (19.4)	338 (24.5)		
Mother's education level						134.83	< 0.001
Less than primary school	3251 (17.7)	2052 (16.6)	344 (16.5)	616 (24.0)	239 (17.3)		
Junior school	6681 (36.3)	4559 (36.9)	667 (32.0)	964 (37.6)	491 (35.6)		
Senior school	4737 (25.8)	3217 (26.0)	575 (27.6)	575 (22.4)	370 (26.9)		
College or above	3717 (20.2)	2533 (20.5)	499 (23.9)	407 (15.9)	278 (20.2)		
Monthly family income (CNY)						231.81	< 0.001
~999	827 (4.5)	482(3.9)	80 (3.8)	207 (8.1)	58 (4.2)		
1000 ~ 1999	1538 (8.4)	937 (7.6)	151 (7.2)	304 (11.9)	146 (10.6)		
2000 ~ 3999	3831 (20.8)	2488 (20.1)	442 (21.2)	599 (23.4)	302 (21.9)		
4000 ~ 5999	4386 (23.9)	3007 (24.3)	475 (22.8)	569 (22.2)	335 (24.3)		
5000 ~ 7999	3292 (17.9)	2259 (18.3)	365 (17.5)	429 (16.7)	239 (17.3)		
8000~	4512 (24.5)	3188 (25.8)	572 (27.4)	454 (17.7)	298 (21.6)		
Aggression						3462.70	< 0.001
No	13,526 (73.6)	10,556 (85.4)	1433 (68.7)	1149 (44.8)	388 (28.2)		
Yes	4860 (26.4)	1805 (14.6)	652 (31.3)	1413 (55.2)	990 (71.8)		

NSSI Nonsuicidal self-injury, *SI* suicide ideation, *SA* Suicide attempt

patterns of different mental health problems. This study is the first to use an LCA approach to further understand the heterogeneity in adolescents' mental health problems and their association with aggression. Four distinct patterns based on depression, anxiety, NSSI, SI, and SA were identified: low-symptom class, self-harm class, emotional symptom class, and high-symptom class. Results indicated that increased levels of aggression had a significant relationship with self-harm class, emotional symptom class, and high-symptom class and these associations were consistent across both males and females. These results underscore the need to take into account the heterogeneity of mental health problems and the role of aggression in understanding and preventing adolescents' mental health problems.

Table 2 Fit statistics for latent class models in the whole sample

Model	AIC	BIC	aBIC	Entropy	BLRT	LMR
5-class	66279.270	66506.031	66413.871	0.841	< 0.001	< 0.001
4-class	**66288.902**	**66468.747**	**66395.654**	**0.842**	< 0.001	< 0.001
3-class	67170.170	67303.099	67249.074	0.875	< 0.001	< 0.001
2-class	68610.469	68696.482	68661.525	0.823	< 0.001	< 0.001

Bolded values indicate the best-fitting model based on fit statistics

AIC Akaike Information Criteria, *BIC* Bayesian Information Criteria, *aBIC* Adjusted Bayesian Information Criteria, *LMR* Lo-Mendell-Rubin Likelihood Ratio, *BLRT* Bootstrapped Likelihood Ratio Tests

Table 3 Latent class of depression, anxiety, NSSI, SI, and SA, and conditional probabilities

Variables	Low-symptom class ($n = 12,361$, 70.8%)	Self-harm class ($n = 2,085$, 9.1%)	Emotional symptom Class ($n = 2,562$, 13.4%)	High-symptom class ($n = 1378$, 6.7%)
Depression				
No	**0.985**	**0.897**	0.198	0.045
Yes	0.015	0.103	**0.802**	**0.955**
Anxiety				
No	**0.992**	**0.980**	0.451	0.183
Yes	0.008	0.020	**0.549**	**0.817**
NSSI				
No	**0.854**	0.449	**0.630**	0.166
Yes	0.146	**0.551**	0.370	**0.834**
SI				
No	**0.959**	0.012	**0.719**	0.000
Yes	0.041	**0.988**	0.281	**1.000**
SA				
No	**1.000**	**0.787**	**0.999**	**0.574**
Yes	0.000	0.213	0.001	0.426

NSSI Nonsuicidal self-injury, *SI* suicide ideation, *SA* Suicide attempt

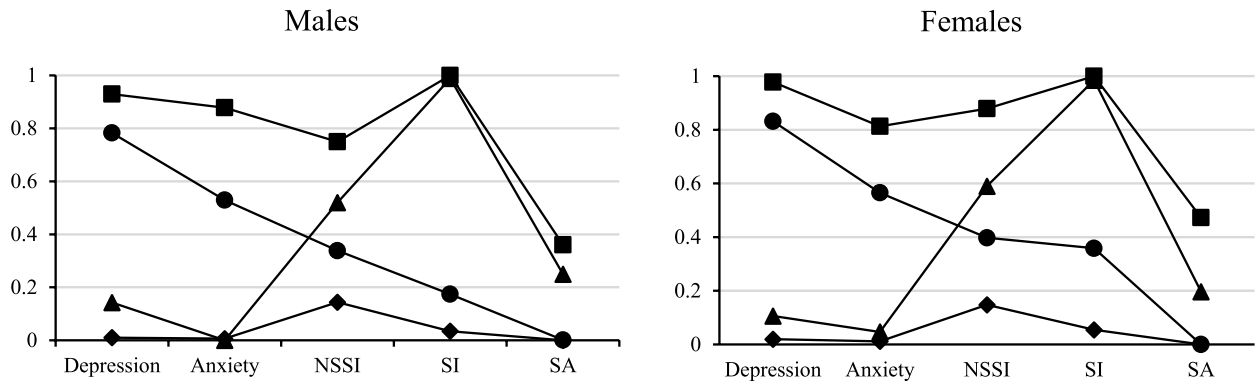

Fig. 2 Conditional probabilities for five mental health problems across classes for males and females. ◆ Low-symptom class; ▲: Self-harm class; ●: Emotional symptom class; ■: High-symptom class. NSSI, Nonsuicidal self-injury; SI, Suicide ideation; SA, Suicide attempt. Males: Low-symptom class (76.0%), Self-harm class (7.4%), Emotional symptom class (11.9%), High-symptom class (4.7%). Females: Low-symptom class (66.2%), Self-harm class (11.0%), Emotional symptom class (14.7%), High-symptom class (8.1%).

Table 4 The interaction items between sex × aggression[a]

Interaction items	Self-harm (95% CI)	emotional symptom (95% CI)	High-symptom (95% CI)
Sex*aggression			
Male*non-aggression	1.00	1.00	1.00
Female *non-aggression	1.70 (1.51–1.90) ***	1.43 (1.26–1.62) ***	2.47 (1.99–3.08) ***
Male *aggression	2.46 (2.09–2.90) ***	6.89 (6.01–7.91) ***	14.22 (11.40–17.74) ***
Female *aggression	4.93 (4.25–5.73) ***	9.55 (8.31–10.96) ***	38.15 (30.95–47.03) ***

*** $p < .001$. [a]The latent class low-symptom was set as the reference in the multivariable logistic regression analyses. All models were adjusted for sex, grade, residence, only child, family type, father's education level, mother's education level, and family income

Table 5 Association of aggression with different latent classes of mental health problems in overall samples, and across males and females

	Latent classes[a]					
	Self-harm class (95% CI)	*p*	Emotional symptom class (95% CI)	*p*	High-symptoms (95% CI)	*p*
Overall samples						
Aggression						
No	1.00		1.00		1.00	
Yes	2.71 (2.44–3.02)	< 0.001	6.87 (6.26–7.55)	< 0.001	15.04 (13.21–17.13)	< 0.001
Males						
Aggression						
No	1.00		1.00		1.00	
Yes	2.44 (2.07–2.87)	< 0.001	6.95 (6.05–7.97)	< 0.001	14.16 (11.34–17.68)	< 0.001
Females						
Aggression						
No	1.00		1.00		1.00	
Yes	2.95 (2.56–3.39)	< 0.001	6.82 (5.99–7.76)	< 0.001	15.66 (13.33–18.41)	< 0.001

All models were adjusted for grade, residence, only child, family type, father's education level, mother's education level, and family income

[a] Low-symptom class was set as the reference category

This study complements the existing studies on the association between aggression and mental health latent classes among adolescents. Through the utilization of LCA, four distinct latent classes were identified. The majority of students, accounting for 70.8%, were classified into the low-symptoms class. There was also a part of individuals in the self-injury class (9.1%) and emotional symptom class (13.4%), these two intermediate-risk groups indicating that individuals tended to exhibit similar mental health problems. Lastly, a small group of participants was identified as the high-symptom class (6.7%), with high probabilities of all mental health symptoms. In line with this study, a previous study has also identified four classes based on mental health problems, which had found high comorbidity of depression, anxiety, NSSI, and SI and shown a small higher proportion (7.5% for males and 7.4% for females) than this study. This may be because this study focused specifically on those who had suffered sexual assault [48]. The identification of the high-symptom class in this study confirms the co-occurrence of multiple mental health problems. This class demonstrated significantly increased likelihoods of concurrent depression, anxiety, NSSI, SI, and SA. The co-occurrence of mental health problems has been previously demonstrated to continue throughout childhood and adolescence [6]. Unlike Parr's study, this study identified a distinct group of self-harm individuals characterized by low depression and anxiety but moderate NSSI and high SI. This class may emerge due to individuals using self-harm as a coping mechanism for emotional distress or underlying psychological factors such as trauma [34]. Additionally, environmental stressors and comorbid conditions like personality disorders could contribute to this unique pattern. Previous research suggested that as the number of comorbidities increases, the clinical severity also intensifies, thereby placing children and adolescents with comorbid mental health problems at a greater risk of adverse outcomes compared to those with single problems [21, 47]. Hence, recognizing and

comprehending the patterns of co-occurrence is crucial for effective prevention and intervention.

As reported in prior research, aggression was strongly correlated with mental health problems [14, 16, 19]. The findings further support this association, revealing adolescents with higher levels of aggression had higher risk classified into at-risk classes and exhibited comorbid patterns of moderate to high mental health problems, rather than low-symptom class. These results align with research indicating that aggression correlates with overall psychopathology, not just specific mental health disorders [59]. This may indicate that aggression is a transdiagnostic risk factor, linked with issues spanning the entire spectrum of psychopathology. The association might indicate about the nature of aggression in mental health problems, highlighting its role as a symptom, a coping mechanism, or a response to underlying distress. Moreover, given the significant emphasis on peer relationships during adolescence, aggression emerges as a notably prominent stress factor in adolescents' lives [9]. According to the failure model and emotion regulation model [4, 13], aggression could result in conflict, social exclusion, poor interpersonal relationships, and failure in academics, as well as negative emotions, increasing the risk of depression, anxiety, NSSI, SI, and SA. For instance, adolescent who are aggressive may have a higher likelihood being reject by their peers and result in depression [63]. The strong correlations between aggression and various mental health issues suggest that measures to prevent and address aggression can effectively diminish mental health problems.

In terms of sex differences, the present study reveals that females account for a higher proportion in all five mental health variables examined, as well as a higher proportion in the three at-risk groups. Similar to the present study, self-reported results of young people treated in substance use clinics also showed that the prevalence of diverse mental health issues is consistently higher in females compared to males [50]. In addition, consistent with previous research, this study identified four latent classes in both sexes [48]. Despite the consistency of four latent classes across males and females, however, the magnitude of odds of class membership varied by sex, with females exhibiting a greater probability of being categorized into the high-symptom class. A potential interpretation of this result could be that mental health problems are generally more common in females [31]. Indeed, females may have a higher tendency to ruminate on negative feelings and thoughts, which could play a role in the onset and persistence of mental health problems [45]. Internalizing negative emotions, as opposed to externalizing them as males often do, may lead to psychological distress, depression, anxiety, and subsequently an increased risk of NSSI, SI, and SA and suicide in females [5, 62]. Conversely, males may be socialized to suppress their emotions, leading to underreporting. In addition, aggression was more strongly associated with females' latent classes, except for the emotional symptom class. This may indicate that aggression has a greater impact on emotional symptoms in males. Males may view aggression as an honorable behavior, however, it is important to note that engaging in aggressive behavior does not earn them acceptance from their peers. Studies have shown that males with aggressive behavior control disorders often experience difficulties in their relationships, which can contribute to a low sense of self-worth and increased anxiety and depression [61]. Therefore, considering these sex differences is crucial for the effective prevention and intervention of mental health problems.

Limitations

The key strengths of this study contain the substantial sample size and the person-centered methodology to identifying mental health classes. However, some limitations need to be noted. Firstly, the cross-sectional nature impedes the ability to establish causal relationships of aggression and mental health classes. Future research could gain valuable insights from employing a longitudinal design, which would allow for the observation of changes over time and potentially establish causal relationships. Secondly, self-reported questionnaire was used to collect data, which may introduce bias due to participants' subjective perceptions and potential underreporting or overreporting of their aggression. Additionally, the absence of information on sensitive questions such SI, and SA could potentially lead to an underestimation of the prevalence. Future studies could consider incorporating additional assessment methods to improve the reliability of the results. Thirdly, the association between aggression and mental health problems could be bidirectional, meaning that each could potentially influence the other [27]. longitudinal designs could indeed provide valuable insights into the complex dynamics between aggression and mental health problems over time. Fourthly, the severity and frequency of NSSI, SI, and SA should be examined in future studies to provide additional support for this study. Last, our study did not examine the transitions of symptoms classes of mental health. Given the rapid development of mental health problems during early adolescence [30], future research could employ latent transition analysis or growth mixture modeling with maximum likelihood estimation to examine the trajectories.

Implications

The present study has potential theoretical and practical implications. The results emphasize the importance of developing a more comprehensive understanding of the complexity and heterogeneity of multiple mental health problems in adolescents. Prior studies suggest that many children neither respond to strategies preventing aggression nor gain advantages from such interventions [6]. This may be partially attributed to the heterogeneity of mental health problems and their co-occurrence. This study identified four latent classes based on depression, anxiety, NSSI, SI, and SA, and explored their association with aggression, which may help the development of more targeted and effective strategies for both prevention and intervention. As there is a significant overlap between aggression and mental health issues [6], assessing aggression in individuals with mental health problems has clinical implications. By identifying aggression associated with specific latent classes, interventions can be tailored more effectively. For example, it is crucial to implement cognitive-behavioral therapy (CBT) to address aggression-related emotional symptoms and to develop school-based programs that focus on the co-occurrence of mental health problems in adolescents with high levels of aggression. Moreover, programs for identifying and promoting mental health and addressing adolescent aggression should be supported by not only clinicians but also schools, teachers, and families.1

Conclusions

The results provide valuable insights into the differences in patterns of mental health problems and deepen understanding of their co-occurring. The present study identified a small subgroup of adolescents who displayed moderate to high probabilities of depression, anxiety, NSSI, SI, and SA. Notably, adolescents with higher aggression were more prone to be classified into high-symptom class, suggesting that aggression level should be considered in the identification and intervention of adolescents' mental health problems. Future research should further explore the underlying mechanisms and contributing factors to better understand how aggression influences mental health problems and to develop more effective, targeted interventions. It is crucial to reinforce the early identification of aggression and mental health problems among adolescents and to develop prevention programs as a key public health goal.

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

FR: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing. MW: Conceptualization, Investigation, Formal analysis, Writing - review & editing. CP: Investigation. JH: Methodology. JC: Investigation. YW: Investigation. YY: Resources, Writing- review & editing, Supervision, Funding acquisition.

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Data availability

The datasets are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study procedures were carried out under the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration. Participants provided informed written consent, and those aged < 18 also obtained written from a legal guardian. The study was approved by the Medical Ethics Committee of Tongji Medical College, Huazhong University of Science and Technology (No. 2021-A216).

Consent for publication

Not Applicable.

Competing interests

The authors declare no competing interests.

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