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Mental health profiles and the related socio-demographic predictors in Hong Kong university students under the COVID-19 pandemic: A latent class analysis

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ABSTRACT

While the COVID-19 pandemic has brought about significant challenges to mental health of university students, there is limited research in this area. Particularly, few studies examined the person-centered mental health symptom profiles such as depression and anxiety and the related socio-demographic predictors. Using Latent Class Analysis (LCA), this study investigated the symptom profiles of depression and anxiety in university students in Hong Kong under the COVID-19 pandemic and the socio-demographic predictors. A total of 978 undergraduate students completed an online questionnaire including socio-demographic factors and measures of depression and anxiety during the summer of 2022. The LCA identified three latent classes: "normal" group, "moderate comorbid depression and anxiety" group and "severe comorbid depression and anxiety" group. Multinominal logistic regression showed that comparing with the "normal" group and the "moderate symptom" group, the "severe symptom" group had higher personal financial difficulties and individual/family member unemployment during the pandemic. In contrast, other socio-demographic factors (age, gender, year of study, living status, and COVID-19 infection status) had no significant association with group status. The study contributes to understanding of person-centered depression and anxiety symptom profiles and the risk role of personal financial difficulty in mental health of university students under the pandemic.

1. Introduction

1.1. Mental health of university students under COVID-19

Since its origination in late 2019, the COVID-19 pandemic has presented significant challenges to the global. With the increasing death and infection rates, the widespread panic and fears in society, and different lockdown, quarantine, and social distancing measures, people's normal daily life has been severely interrupted, and their mental health has been largely influenced (Cao et al., 2022; Shek et al., 2021). Particularly, there is a high prevalence of depression and anxiety: the two most common comorbid mental health problems in the general population and different subgroups. Different studies concertedly suggest a high and increased level of depression (around 33,7 % in a review) and anxiety (around 35 % in a review) in the general population although there were study-based variances (Lakhan et al., 2020; Salari et al., 2020). Among different subgroups in society, university students are a highly vulnerable group that may suffer more from the pandemic due to their specific developmental stage and encountered life challenges and tasks. Many university students, particularly those at the undergraduate level, are in the developmental stage from late adolescence to early adulthood which faces important developmental tasks such as establishing self-identity in life and occupation, achieving independence, emotional regulation, and navigating interpersonal and intimate relationships (Bantjes et al., 2022; Johnson, 2009; Sestito et al., 2015). However, the pandemic severely impacted campus life in which many university students have to stay at home and attend online courses. The isolated situation greatly hindered their needs for social and interpersonal development and identity development in the social context. In addition, university students face the abrupt transition from in-person classes to online classes, the changed arrangement of evaluation and assessment, the elevated financial burdens, and the increasing uncertainty about employment situation and job prospects. These may all increase their risk of developing mental problems such as anxiety and

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depressive symptoms (Nassr et al., 2020; Pat-Horenczyk et al., 2022; Schiff et al., 2021).

Studies identified a high prevalence of anxiety and depressive symptoms among students in higher education institutions across different countries and districts, which were generally higher than the rates in the general population. For example, in a study based on 874 Bangladesh university students, 40 and 72 % of the students experienced anxiety and depressive symptoms (ranging from moderate to severe levels), respectively (Faisal et al., 2022). Another study on 1,224 Brazilian university students showed a prevalence rate of 52.5 % and 60.5 % for anxiety and depression (Lopes and Nihei, 2021). In addition, a study on 11,133 Chinese university students showed that 24.9 % and 37.0 % of the students were experiencing anxiety and depression during the pandemic (Zhou et al., 2021). Furthermore, a systematic review and meta-analysis of studies conducted in different countries showed a prevalence rate of 29 % for anxiety and 37 % for depression in college students (Wang et al., 2021).

While the above studies suggested a high prevalence of depression and anxiety in university students under COVID-19, several research gaps exist that need further investigation. First, there are limited studies investigating mental health conditions particularly anxiety and depressive symptoms among students in universities in Hong Kong which is a society blending both Chinese and Western cultures (Shek et al., 2022a, 2023). Due to the highly competitive culture of the society and some long-lasting social problems such as lower social-class mobility and higher housing prices (Wong and Chu, 2017), Hong Kong university students may face more challenges and pressure during the pandemic. Second, most of the extant studies on mental problems in students in higher education institutions under COVID-19 adopted a "variable-centered" approach which focuses on computing the prevalence statistics based on individual variables such as depression or anxiety. There is quite limited research conducted based on a "person-centered" approach to understand the characteristics or subgroups of students in higher education on a set of comorbid and highly correlated mental health problems such as anxiety and depression. In other words, the "person-centered" approach focuses on identifying the heterogeneities in a population based on an individual variable or a set of variables (Lanza and Cooper, 2016). Third, while understanding important socio-demographic associates of university students' mental health problems is vital for identifying the risk groups, limited research has been conducted in this area. In addition, there are few studies conducted on understanding the socio-demographic predictors of student subgroups with different depression and anxiety profiles. To fill these research gaps, this study adopted a person-centered approach to examine the profiles of depression and anxiety symptoms in students in Hong Kong higher education institutions during the pandemic through Latent Class Analysis (LCA). In the following paragraphs, the data analytical approach of LCA will be reviewed, together with the review of the existing few studies on depression and anxiety using LCA and studies on socio-demographic predictors of the two mental health problems in university students under COVID-19.

1.2. Understanding person-centered characteristics of anxiety and depressive symptoms in university students

In the past decades, there has been increasing research on comorbidity between anxiety and depression in youth and adolescents. Theoretically, different models and pathways have been proposed for the anxiety-depression comorbidity: one model regards that anxiety precedes depression in which depression is a result of anxiety-related impairment; another model proposes that anxiety and depression may have common etiological risk (e.g., shared predisposition or family risk) and they occur simultaneously; a third model regards that depression precedes anxiety in which anxiety is a result of depression-related impairment (Cummings et al., 2014; Garber and Weersing, 2010). Particularly, scholars argued that the second model applies more to generalized anxiety and depression. Supporting the theoretical propositions, empirical studies also showed a high association between anxiety and depression in adolescents and youth including students in higher education (Beiter et al., 2015; Ferdinand et al., 2005; Jadoon et al., 2010). Due to the high association and comorbidity, it is of particular importance to identify subgroups in university students with homogeneous patterns or characteristics of depressive and anxiety symptoms. First, due to their high comorbidity, understanding the potential subgroups with homogeneous characteristics of anxiety and depressive symptoms can contribute to the knowledge of the person-centered feature of the two mental health problems and contribute to the further exploration of their etiology in a deeper manner (Beijers et al., 2019). Second, the identification of subgroups with homogeneous characteristics of depressive and anxiety symptoms would provide important information for devising and implementing more targeted treatment and intervention strategies, which contributes to the effectiveness of prevention and intervention (Beijers et al., 2019; Ferdinand et al., 2005). However, existing research on depression and anxiety of university students mainly adopted a variable-centered approach which focused on prevalence rates of depression and anxiety and their respective predictors. A person-centered approach is highly needed to identify subgroups in the population of university students with different comorbid profiles of anxiety and depression and understand the sociodemographic predictors of different groups.

LCA is an analytical approach aiming at identifying "population heterogeneity" on a set of related variables/constructs instead of focusing on identifying statistical patterns of individual variables (Lanza and Cooper, 2016). Different from the variable-centered approach, LCA is a "person-centered approach" that examines individuals' differences in terms of a set of indicators. LCA is widely used in different research fields such as psychology, education, and social science (Pavlova et al., 2022; van Lang et al., 2006). Particularly, scholars argued the increasing importance of LCA in developmental research in children and adolescents due to the multidimensional and even heterogeneous nature of many developmental constructs and the complex comorbidity between these constructs. One biggest strength of LCA is that it can identify subgroups in a population with "similar patterns of mental health indicators" (Peterson et al. 2019, p. 2). For example, LCA was adopted to measure subgroups in adolescents or university students on the co-occurrence of multiple health-risk behaviors (Ahmadi-Montecalvo et al., 2019; Hutchesson et al., 2021). It was also used to identify the subgroups of adolescents with comorbid mental health disorders (Essau and de la Torre-Luque, 2019).

Regarding anxiety and depression, it is interesting and important to understand "which comorbidity patterns of anxiety and depressive disorders exist" in child and adolescent development (van Lang et al. 2006, p. 850). It might be possible that depression exists without the occurrence of anxiety or anxiety develops without the presence of depression (van Lang et al., 2006; Peterson et al., 2019). However, the existing related studies are quite few. An early-time study on 1,987 U.S. children and adolescents based on LCA identified a three-group model: low-level depression and anxiety group, middle-level depression and anxiety group, and high-level depression and anxiety group (Wadsworth et al., 2001). Another study on 3,145 Dutch young adolescents (10–12 years) using LCA showed a five-group model: three groups with low, medium, and high levels of comorbid depression and anxiety and two groups with main depression (i.e., high probability of depression but low probability of anxiety) or main anxiety (van Lang et al., 2006). However, the two groups with main depression or main anxiety had small numbers of participants. In addition, a study on 2,032 referred adolescents using LCA identified subgroups characterized by severe-level symptoms in both anxiety and depression and a subgroup characterized by severe anxiety but mild depression (Ferdinand et al., 2005). While these studies provide certain indications on the comorbidity pattern of anxiety and depression, they were mainly focused on children and early adolescents, were conducted before the pandemic, and were based on samples in

Western societies. A recent study on 29,663 medical students in mainland China during the COVID-19 pandemic using LCA also identified a three-class model for anxiety and depression symptoms: each group corresponding to the severe-level, mild-level, and low-level of comorbid symptoms, respectively (Liu et al., 2021). However, this study was conducted mainly based on medical students who may have different patterns of anxiety and depression compared with the general university students. In view of the limited research in the field, investigating the comorbid patterns of anxiety and depressive symptoms in students in universities in Hong Kong during the pandemic by using LCA is needed. This would not only contribute to the theoretical understanding of the linkage between the two mental disorders but also provide important information for inclusion criteria for the treatment of these disorders.

1.3. Socio-demographic predictors of latent class groups with different symptoms of anxiety and depression

Besides understanding subgroups of students with different symptoms of anxiety and depression, it is also important to identify the potential risk and protective factors for the subgroups. One category of important correlates of mental issues in university students is socio-demographic factors. However, quite limited research was conducted in this area. Most of the existing studies adopted a variable-centered approach to investigate the socio-demographic predictors of depression and/or anxiety in university students during the pandemic and these studies revealed some socio-demographic correlates of psychological morbidity. For example, a body of research suggests that female students may suffer more from anxiety and depressive symptoms than male students under COVID-19 (Chen and Lucock, 2022; Ghazawy et al., 2021), although there were also studies showing no predictive effect or even opposite predictive effect of gender (Faisal et al., 2022; Islam et al., 2020; Shek et al., 2022a, 2022b). In addition, there are inconsistent findings on the associations between age and anxiety and depression (Chi et al., 2020; Debowska et al., 2020; Lopes and Nihei, 2021). Furthermore, students experiencing financial difficulties might be more vulnerable to the negative impact of the pandemic and to the development of anxiety and depressive symptoms. For example, a study on 6,157 Jordan undergraduate students showed that students' economic difficulties during the quarantine time significantly predicted their depressive symptoms (Saadeh et al., 2021). Similarly, another study on Philippine university students identified that financial difficulty encountered by oneself during the pandemic was positively associated with students' anxiety and depression (Galanza et al., 2023). Moreover, personal infection or family members' infection of the virus might be a risk factor for the mental health of students in universities. For instance, a study on Mexican college students found that those infected with COVID-19 had higher levels of anxiety and depressive symptoms (Dosil-Santamaria et al., 2022). Another large-scale study on 44,447 college students in mainland China revealed that having family members who tested positive for COVID-19 or were suspected of being infected with the virus was positively associated with depressive symptoms (Wang et al., 2020).

Although the above studies indicate the association between anxiety and depression and some socio-demographic factors such as gender, age, financial problems, and infection of the virus, the findings are still inconclusive. In addition, there have been limited studies examining the connection between these socio-demographic factors and mental health issues such as anxiety and depression in university students using a person-centered approach. Only two studies were identified in this area. Wadsworth et al. (2001)'s study based on LCA found an association between age, gender, and latent-class groups in which elderly girls demonstrated higher levels of comorbid anxiety and depression. Using LCA, Liu et al. (2021) also showed that more female medical students were in the higher and mild depression and anxiety groups compared with the normal group. The literature is quite limited and there has been no study conducted to examine the role and effects of other important socio-demographic factors such as financial hardship and personal infection of the virus on depression and anxiety through a person-centered approach using LCA. In addition, there is no research conducted in Hong Kong. The pandemic has exerted a substantial influence on the world economy, leading to higher rates of unemployment, reduced income, and financial instability and insecurity (Bashir et al., 2020; Kim et al., 2022). In Hong Kong, many university students conduct part-time work to afford their own tuition fees (Chu, 2021); they may face greater financial difficulties during the pandemic, which constitutes a major stressor for their development of mental health problems such as anxiety and depression (ElTohamy et al., 2022; Pietrabissa and Simpson, 2020).

1.4. Purpose of the study

Taking into account the above review of the literature, the present study aimed to investigate the subgroups of university students on symptoms of anxiety and depression under COVID-19 using LCA and investigate the socio-demographic predictors of the subgroups. Two research questions were addressed based on the study purpose.

Research Question 1. What is the profile of latent groups of university students with different symptoms of anxiety and depression under the pandemic?

Research Question 2. What are the socio-demographic predictors of the latent groups of university students with comorbid anxiety and depression? Particularly, informed by the literature (Galanza et al., 2023; Saadeh et al., 2021), we hypothesized that higher financial difficulty would be associated with the subgroup characterized by higher-level anxiety and depressive symptoms (Hypothesis 1).

2. Methods

2.1. Participants and procedure

The study was based on the data collected in a research project investigating the psychological well-being of university students under COVID-19 (Shek et al., 2023). Ethical review of the project was conducted and ethical approval of conducting the project was granted by the Institutional Review Board of the authors' affiliated institution. The data collection was conducted in the summer (from June to August) of 2022 which was at the middle stage of the fifth wave of the pandemic in Hong Kong in which there were a high number of confirmed cases and the stringent anti-pandemic measures of the government. The participants were undergraduate students coming from The Hong Kong Polytechnic University, a public university in Hong Kong. The method of quota sampling was adopted in recruiting the participants with students' year of study and faculty as two considering characteristics. During the data collection period, as all the courses were conducted in online mode based on the policy of the University and students mainly stayed at home to conduct their study activities, the recruited participants were invited to complete a survey questionnaire in an online mode. The questionnaire included socio-demographic information and measures of the mental health of university students. Before doing the questionnaire, formal consent was obtained from each participant and all the participants were informed of the principle of free withdrawal and confidentiality of data and personal information. A total of 978 students finally completed the questionnaire (Shek et al., 2023).

2.2. Measures

2.2.1. Anxiety and depression

The participants' anxiety and depressive symptoms were assessed through the "Depression" and "Anxiety" Subscales of the short-form "Depression, Anxiety, and Stress Scales" (DASS-21). The original DASS

scale contains 42 items that measure three mental distresses, namely depression, anxiety, and stress in non-clinical samples (Lovibond and Lovibond, 1995). The scale has been validated in different cultural groups and shown good psychometric properties (Crawford and Henry, 2003; Li et al., 2021; Moussa et al., 2017). As a shortened version of DASS, DASS-21 has three subscales, with each subscale containing seven items. DASS-21 has been widely used in different studies including studies based on adolescent and university student samples and demonstrated good psychometric properties (Cheung et al., 2020; Esteves et al., 2021; Lu et al., 2018). All the items were rated through a four-point measure from "0″ representing "not at all" to "3″ representing "most of the time". The internal consistency of the Depression and Anxiety subscales in this study was found to be favorable, with Cronbach's alpha coefficients of 0.88 and 0.83 respectively.

2.2.2. Socio-demographic correlates

As existing research suggests that students' depression and anxiety were associated with age, gender, year of study, student status, and living status (e.g., Chen and Lucock 2022; Dhar et al. 2020; Lopes and Nihei 2021), these socio-demographic factors were included in the LCA analyzes as correlates to examine their predictive effects on latent groups. Specifically, age was assessed by indicating ages in integers (years). The participants indicated their gender information ("*male*", "*female*", and "*prefer not to say*" with "*prefer not to say*" being coded as missing value), year of study ("*Year 1*″, "*Year 2*″, "*Year 3*″, and "*Year 4*″), student status ("*local*", "*international*"), and living status ("*live alone*", "*living with family or roommates*"). In addition, as socioeconomic status and financial difficulties were also shown to be linked with mental health issues in university students during the pandemic (e.g., Galanza et al., 2023; Saadeh et al. 2021), these factors were also included in the LCA analyzes as correlates. In specific, the participants provided information on socioeconomic status (whether their families receive or do not receive "Comprehensive Social Security Assistance"), financial difficulty ("*do you experience financial difficulty at the present time?*"), and personal or family members' unemployment ("*have you or your family member(s) become unemployed during the COVID-19 pandemic?*"). Furthermore, we also included the experience of infection with COVID-19 as covariates ("*have you tested positive for COVID-19 since early 2020?*" and "*have your family members tested positive for COVID-19 since early 2020?*") according to the literature (Ghazawy et al., 2021; Luo et al., 2021). In addition, as the government pandemic prevention policy and university teaching and learning situation were relatively stable during the data collection period, we believe that the students' questionnaire completion will not be influenced by these factors. Therefore, we did not include these factors as covariates or control variables in our analyzes.

2.3. Latent class indicators

In this study, the seven depressive symptoms assessed in the Depression subscale and the seven anxiety symptoms assessed in the Anxiety subscales in DASS-21 were used as indicators of latent classes with different characteristics of depression and anxiety in the LCA analyzes. To facilitate model interpretation and focus more on the risk status of the participants in the latent class formation, the participant's responses to each item assessing one specific depressive symptom or anxiety symptom in the Anxiety and Depression subscales of DASS-21 was recoded to a binary answer: "0″ (not at all) was recoded to "0" (absence of symptom)"; "1″ (sometimes), "2" (frequently) and "3″ (most of the time) were recoded to "1" (presence of symptom). This practice has been commonly adopted in different studies using LCA (e.g., Lei et al. 2022; Rosato and Baer 2012; Veltman et al. 2017). Also, according to the suggestion of Weller et al. (2020), "if risk status is of interest in class formation, multiple response categories associated with negative outcomes may be collapsed into a 'risk present' category and the rest collapsed into a 'risk not present' category" (p. 291).

2.4. Data analysis

Several steps of analysis were conducted. In the first step, descriptive statistical analyzes were performed using SPSS (Version 26). This included computing the mean, standard deviation (SD), Cronbach's alpha and mean inter-item correlation for the measures of depression and anxiety, as well as the socio-demographic profile of the sample. In the second step, LCA was conducted using Mplus (Version 8.3) to identify latent classes (subgroups) in the participants based on their responses to different symptoms of anxiety and depression. LCA is a statistical technique aiming at identifying heterogeneity in a population (i.e., latent classes or hidden groups) based on a set of observable indicators (Lanza and Cooper, 2016; Nylund-Gibson and Choi, 2018).

To decide and identify the appropriate number of latent classes, several LCA models with different numbers of classes were examined and multiple fit indices were used to compare the different models. Normally, the model testing starts by examining the fit indices of a single-class model (Model 1) which is the baseline model for comparison; then examining a 2-class model (Model 2) and comparing its fit indices with those of the single-class model. If the 2-class model is superior to the single-class model, then continue to examine a 3-class model (Model 3) and compare it with the 2-class model. The model testing will not stop until the fit indices of the next model will not be superior to the previous model. Three sets of fit indices would be involved in deciding the best-fitted model. The initial set of fit indices consists of information criteria which include Akaike's Information Criterion (AIC), Bayesian Information Criterion (BIC), and sample-size adjusted Bayesian Information Criteria (SABIC). For information criteria, lower values indicate a better model fit (Sinha et al., 2021). The second set of fit indices comprised likelihood-based tests, such as the Vuong-Lo-Mendell-Rubin adjusted likelihood ratio test (VLMR-LRT) and Bootstrapped likelihood ratio (BLRT) (Vermunt and Magidson, 2004). Both tests provide p values examining whether the model with one additional class would have significant improvement than the previous model. Third, entropy was used which examines how well the latent classes are differentiated (Sinha et al., 2021). The higher the value, the better the class differentiation. Also, a value over 0.80 for entropy indicates a "desirable" differentiation and classification of participants into latent classes (Vermunt and Magidson, 2004).

In the third step, logistic regression was conducted by adding correlates to the LCA analyzes to identify the predictive effects of socio-demographic factors on latent classes. First, bivariate analysis was conducted to examine the association between each of the ten socio-demographic correlates and latent classes. Then, multinominal logistic regression was conducted by adding the socio-demographic factors which had significant effects in the bivariate analyzes. All the analyzes were conducted through Mplus (Version 8.3).

3. Results

3.1. Descriptive statistics of variables and characteristics of the sample

The mean, SD, and reliability statistics are shown in Table 1. Regarding the socio-demographic profile of the sample, the participants had an average age of 20.69 ± 1.61 years, with 62.9 % being female and 34.4 % being male. Among the participants, 42.7 %, 32.9 %, and 24.3 % were in Year 2, Year 3, and Year 4, respectively. 93.8 % were local and

Table 1
Descriptive statistics of the major variables.

Variable	Mean	SD	Cronbach's alpha	Mean inter-item correlation
DASS-Depression	5.55	4.15	0.88	0.51
DASS-Anxiety	5.24	3.79	0.83	0.42

6.2 % were international students; 97.8 % were living with family members or roommates and 2.2 % were living alone. 4.6 % of the participants' families were receiving "Comprehensive Social Security Assistance" (CSSA); 28.5 % reported having personal financial problems and 21.1 % of the students reported that themselves or their family members experienced unemployment during the pandemic. Lastly, 23.7 % of the participants had tested positive for COVID-19 since early 2020 and 36.6 % of the participants had family members tested positive for COVID-19 since early 2020.

3.2. Selection of LCA models on profiles of symptoms of anxiety and depression under the pandemic

The model fit indices of different LCA models with different numbers of latent class solutions are shown in Table 2. Comparing the information criteria that are AIC, BIC, and SABIC, the information criteria values in the four-class solution (i.e., Model 4) were smaller than those in the three-class solution (i.e., Model 3) which were smaller than the values in the two-class solution (i.e., Model 2). Comparing the likelihood-based tests, the significant p value (<0.001) for VLMR-LRT and BLRT in the three-class solution indicated that the three-class solution was better than the two-class solution. However, the non-significant p value ($=0.066$) for VLMR-LRT in the four-class solution indicated that there was no significant improvement in the four-class solution compared with the three-class solution. With regard to the value of entropy, the value 0.863 in the three-class solution and the value 0.819 in the four-class solution indicated that the three-class solution was better than the four-class solution. Therefore, considering the three sets of criteria altogether, the three-class solution (Model 3) was adopted as the best-fitted model.

The probabilities of items on depression and anxiety symptoms in the three latent classes are shown in Table 3 and Fig. 1. For the students in Class 1 ($n = 253$, 25.9 %), their probabilities of having all the depression and anxiety symptoms were below 0.16 except for one symptom in depression "I found it difficult to work up the initiative to do things" (42.1 %) and two symptoms in anxiety "I was aware of dryness of my mouth" (39.6 %) and "I was worried about situations in which I might panic and make a fool of myself' (25.2 %). However, the probabilities of the three symptom items were still lower than those in other classes. Therefore, Class 1 was identified and labeled as the "normal" class. For the students in Class 2 ($n = 376$, 38.4 %), their probabilities of having different depression and anxiety symptoms were between 35.6 % and 55.9 %, except for the previously mentioned three symptoms (between 71.0 % and 81.8 %) and an additional symptom "I felt downhearted and blue" (75.7 %). However, the probabilities of the four symptoms were still lower than those in Class 3. Therefore, Class 2 was labeled as the "moderate comorbid depression and anxiety" class. The students in Class 3 ($n = 349$, 35.7 %) demonstrated very high probabilities in all the depression and anxiety symptoms (all above 90 % except for two symptoms being 80.2 % and 87.1 %). Therefore, we labeled this class as the "severe comorbid depression and anxiety" class.

To further understand the profiles of the depressive and anxiety symptoms of the three latent classes, frequencies and percentages of the reported depressive and anxiety symptoms as well as the mean numbers and SD of the reported depressive and anxiety symptoms in each latent class were calculated and shown in Table 4. It could be identified that there were generally lower percentages of reported depressive and anxiety symptoms in the "normal" Class (below 15 %) except for three symptoms "I found it difficult to work up the initiative to do things" (41.9 %, symptom in depression), "I was aware of dryness of my mouth" (40.3 %, symptom in anxiety), and "I was worried about situations in which I might panic and make a fool of myself") (23.7 %, symptom in anxiety). For the "moderate comorbid depression and anxiety" Class, the percentage of reported depressive and anxiety symptoms ranged between 35.9 % to 55.9 %, except for four symptoms "I found it difficult to work up the initiative to do things" (81.4 %, symptom in depression), "I

Table 3
Estimated probabilities of depression and anxiety symptoms in the three latent classes.

Symptoms	Class 1 "Normal" Class	Class 2 "Moderate comorbid depression and anxiety" Class	Class 3 "Severe comorbid depression and anxiety" Class
Depressive Symptoms			
I couldn't seem to experience any positive feelings at all	0.105	0.559	0.946
I found it difficult to work up the initiative to do things	0.421	0.818	0.963
I felt that I had nothing to look forward to	0.129	0.552	0.950
I felt down-hearted and blue	0.153	0.757	0.987
I was unable to become enthusiastic about anything	0.075	0.505	0.949
I felt I wasn't worth much as a person	0.043	0.368	0.911
I felt life was meaningless	0.085	0.397	0.929
Anxiety Symptoms			
I was aware of dryness of my mouth	0.396	0.710	0.927
I experienced breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion)	0.089	0.356	0.802
I experienced trembling (e.g., in the hands)	0.069	0.376	0.871
I was worried about situations in which I might panic and make a fool of myself	0.252	0.817	0.969
I felt I was close to panic	0.043	0.429	0.967
I was aware of the action of my heart in the absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat)	0.076	0.511	0.906
I felt scared without good reason	0.079	0.424	0.923

Table 2
Model fit indices of different latent-class number solutions in different LCA models.

Model	Loglikelihood	AIC	BIC	SABIC	VLMR-LRT p value	BLRT p value	Entropy
1 Class	−9051.012	18,130.025	18,198.422	18,153.957	n/a	n/a	n/a
2 Class	−7137.734	14,333.467	14,475.147	14,383.043	0.000	0.000	0.902
3 Class	−6766.041	13,620.081	13,835.044	13,695.299	0.000	0.000	0.863
4 Class	−6687.138	13,492.275	13,780.520	13,593.136	0.066	0.000	0.819

Note. Model fit indices for the selected model are highlighted. AIC: Akaike's Information Criterion; BIC: Bayesian Information Criterion; SABIC: sample-size adjusted Bayesian Information Criteria; VLMR-LRT: Vuong-Lo-Mendell-Rubin adjusted likelihood ratio test; BLRT: Bootstrapped likelihood ratio.

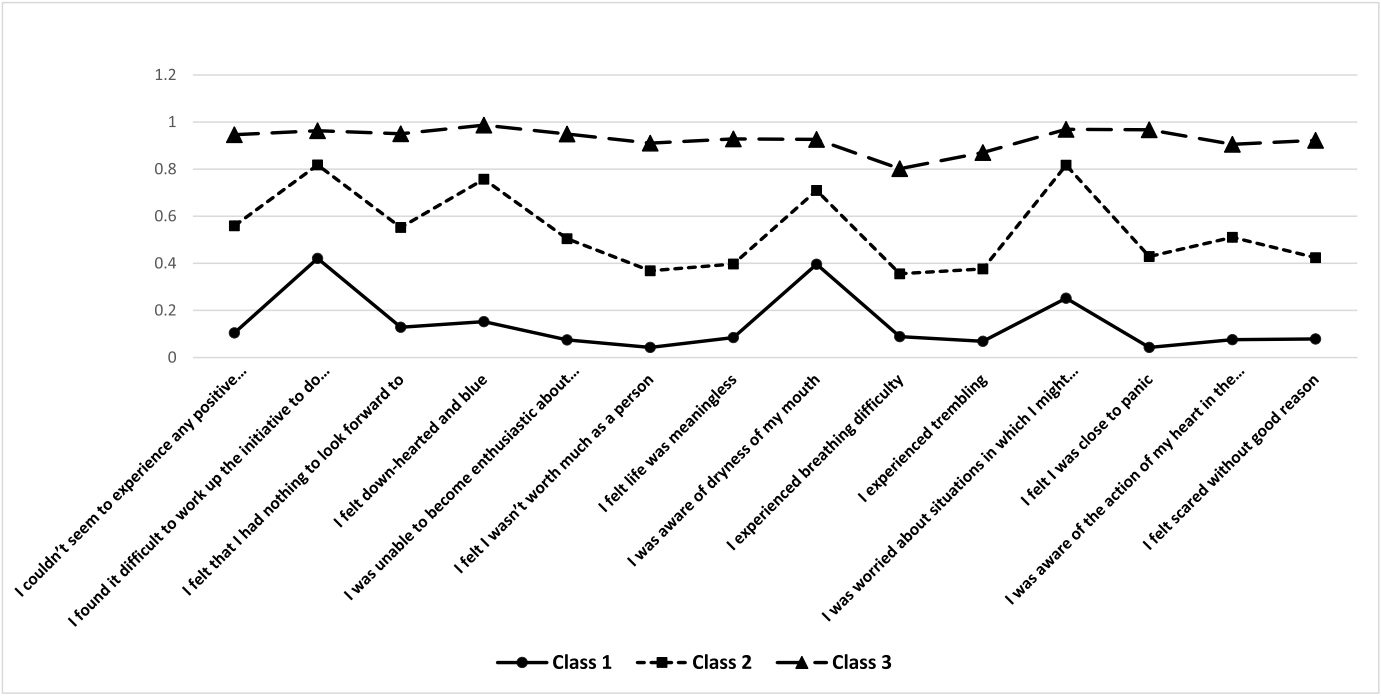

Fig. 1. Graph of Probability Estimates for Sympotoms of Depression and Anxiety by Latent Class.

felt down-hearted and blue" (75.5 %, symptom in depression), "I was aware of dryness of my mouth" (70.2 %, anxiety symptom), and "I was worried about situations in which I might panic and make a fool of myself" (82.4 %, anxiety symptom). For the "severe comorbid depression and anxiety" Class, the percentages of reported depressive and anxiety symptoms were very high for most of the symptoms (ranging from 91.1 to 98.9 %) except for two anxiety symptoms for which the percentages were a bit lower including "I experienced breathing difficulty" (79.1 %) and "I experienced trembling" (86.5 %). The results of One-Way ANOVA showed significant differences in mean numbers of depressive symptoms and anxiety symptoms across the three groups, respectively (depressive symptoms: $F = 1870.986$, $p < 0.001$; anxiety symptoms: $F = 1591.671$, $p < 0.001$).

3.3. Socio-demographic predictors of symptoms profiles

3.3.1. Univariate logistic regression in LCA with socio-demographic correlates

The socio-demographic profiles of each latent class are shown in Table 5. In factors of receiving CSSA, experiencing personal financial difficulty, and experiencing oneself/family member unemployment, the percentages of the "severe comorbid depression and anxiety" Class were higher than those of the "moderate comorbid depression and anxiety" Class which were further higher than those of the "normal" Class. To examine the associations between different socio-demographic factors and the latent groups, we first conducted the univariate logistic regression by adding each individual socio-demographic factor in the LCA analyzes to examine its predictive effect on latent groups. Table 6 presents the results of univariate analyzes. As shown in Table 6, living status, CSSA, personal financial difficulty, unemployment of oneself or family members, and family members tested positive for COVID-19 showed significant predictive effects. In specific, compared to the likelihood in the "normal" group (Class 1, the reference class), the likelihood of living alone ($B = 2.118$, $SE = 1.047$, $p < 0.05$, OR = 8.315, 95 %CI, 1.069–64.680) was 8.315 times higher in the "severe comorbid depression and anxiety" group (Class 3); the likelihood of family receiving CSSA ($B = 1.464$, $SE = 0.503$, $p < 0.01$, OR = 4.323, 95 %CI, 1.614–11.578) was 4.323 times higher in the "severe comorbid depression and anxiety" group; the likelihood of having personal financial difficulties ($B = 1.047$, $SE = 0.213$, $p < 0.001$, OR = 2.848, 95 %CI, 1.875–4.328) was 2.848 times higher in the "severe comorbid depression and anxiety" group; and the likelihood of unemployment of oneself or family members ($B = 1.004$, $SE = 0.257$, $p < 0.001$, OR = 2.728, 95 %CI, 1.648–4.515) was 2.728 times higher in the "severe comorbid depression and anxiety" group.

In addition, compared to the likelihood in the "normal" group (Class 1, the reference class), the likelihood of having personal financial difficulties ($B = 0.504$, $SE = 0.229$, $p < 0.05$, OR = 1.655, 95 %CI, 1.057–2.592) was 1.655 times higher in the "moderate comorbid depression and anxiety" group (Class 2); the likelihood of unemployment of oneself or family members ($B = 0.613$, $SE = 0.269$, $p < 0.05$, OR = 1.845, 95 %CI, 1.088–3.128) was 1.845 times higher in the "moderate comorbid depression and anxiety" group; and the likelihood of having family members tested for COVID-19 ($B = 0.516$, $SE = 0.210$, $p = 0.01$, OR = 1.676, 95 %CI, 1.109–2.531) was 1.676 times higher in the "moderate comorbid depression and anxiety" group. Furthermore, compared to the likelihood in the "moderate comorbid depression and anxiety" group (Class 2, the reference class), the likelihood of family receiving CSSA ($B = 1.379$, $SE = 0.464$, $p < 0.01$, OR = 3.973, 95 %CI, 1.601–9.857) was 3.973 times higher in the "severe comorbid depression and anxiety" group; and the likelihood of having personal financial difficulty ($B = 0.543$, $SE = 0.186$, $p < 0.01$, OR = 1.721, 95 %CI, 1.195–2.478) was 1.721 times higher in the "severe comorbid depression and anxiety" group. Based on the results of univariate analyzes, the five socio-demographic factors: living status, CSSA, personal financial difficulty, unemployment of oneself or family members, and family members tested positive for COVID-19 were selected as covariates in the final multivariate logistic regression in the LCA analyzes. As the correlation coefficients between the five involved socio-demographic variables were all below 0.35 and the VIF values were all below 2, the weak multicollinearity among these variables did not constitute a major problem in data analysis in multivariate logistic regression.

3.3.2. Multivariate logistic regression in LCA with socio-demographic correlates

Table 7 presents the results of multivariate logistic regression in LCA

Table 4
Frequency, percentage, and mean number of depression and anxiety symptoms in the three latent classes.

Symptoms	Class 1 "Normal" Class	Class 2 "Moderate comorbid depression and anxiety" Class	Class 3 "Severe comorbid depression and anxiety" Class	
	n (%)	n (%)	n (%)	
Depressive Symptoms				
I couldn't seem to experience any positive feelings at all	25 (9.9 %)	210 (55.9 %)	329 (94.3 %)	
I found it difficult to work up the initiative to do things	106 (41.9 %)	306 (81.4 %)	337 (96.6 %)	
I felt that I had nothing to look forward to	36 (14.2 %)	201 (53.5 %)	332 (95.1 %)	
I felt down-hearted and blue	37 (14.6 %)	284 (75.5 %)	345 (98.9 %)	
I was unable to become enthusiastic about anything	18 (7.1 %)	188 (50.0 %)	331 (94.8 %)	
I felt I wasn't worth much as a person	10 (4.0 %)	135 (35.9 %)	318 (91.1 %)	
I felt life was meaningless	10 (4.0 %)	135 (35.9 %)	318 (91.1 %)	
Anxiety Symptoms				
I was aware of dryness of my mouth	102 (40.3 %)	264 (70.2 %)	323 (92.6 %)	
I experienced breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion)	22 (8.7 %)	135 (35.9 %)	276 (79.1 %)	
I experienced trembling (e.g., in the hands)	16 (6.3 %)	141 (37.5 %)	302 (86.5 %)	
I was worried about situations in which I might panic and make a fool of myself	60 (23.7 %)	310 (82.4 %)	338 (96.8 %)	
I felt I was close to panic	10 (4.0 %)	158 (42.0 %)	338 (96.8 %)	
I was aware of the action of my heart in the absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat)	17 (6.7 %)	193 (51.3 %)	315 (90.3 %)	
I felt scared without good reason	17 (6.7 %)	160 (42.6 %)	321 (92.0 %)	
	Mean (SD)	Mean (SD)	Mean (SD)	F^a
Mean number of depressive symptoms	1.00 (1.00)	3.90 (1.51)	6.64 (0.58)	1870.986***
Mean number of anxiety symptoms	0.96 (0.93)	3.62 (1.47)	6.34 (0.90)	1591.671***

Note. [a]One-way ANOVA; *** $p < 0.001$.

Table 5
Sociodemographic profiles of the three latent classes of anxiety and depression.

Sociodemographic factors	Class 1 "Normal" Class ($N = 253$)	Class 2 "Moderate comorbid depression and anxiety" Class ($N = 376$)	Class 3 "Severe comorbid depression and anxiety" Class ($N = 349$)
	n (%)	n (%)	n (%)
Gender			
Male	79 (32.2 %)	124 (33.8 %)	133 (39.2 %)
Female	166 (67.8 %)	243 (66.2 %)	206 (60.8 %)
Year of Study			
The Second Year	101 (39.9 %)	173 (46.0 %)	144 (41.3 %)
The Third Year	83 (32.8 %)	119 (31.6 %)	120 (34.4 %)
The Fourth Year	69 (27.3 %)	84 (22.3 %)	85 (24.4 %)
Student Status			
Local	234 (92.5 %)	354 (94.1 %)	329 (94.3 %)
International	19 (7.5 %)	22 (5.9 %)	20 (5.7 %)
Living Status			
Living alone	9 (2.4 %)	1 (0.4 %)	12 (3.4 %)
Living with family members or roommates	367 (97.6 %)	252 (99.6 %)	337 (96.6 %)
CSSA			
Receiving CSSA	6 (2.4 %)	11 (3.0 %)	28 (8.5 %)
Not receiving CSSA	243 (97.6 %)	359 (97 %)	303 (91.5 %)
FD_P			
With personal financial difficulty	48 (20.6 %)	101 (28.7 %)	130 (40.0 %)
Without personal financial difficulty	185 (79.4 %)	251 (71.3 %)	194 (59.9 %)
FU			
Having unemployment of oneself or family members under COVID-19	35 (14.7 %)	78 (22.1 %)	93 (28.9 %)
Not having unemployment of oneself or family members under COVID-19	203 (85.3 %)	275 (77.9 %)	229 (32.4 %)
COVID_IND			
Having personal infection of COVID-19	52 (21.3 %)	89 (24.2 %)	91 (27.4 %)
Not having personal infection of COVID-19	192 (78.7 %)	279 (75.8 %)	241 (72.6 %)
COVID_FAM			
Family member infection of COVID-19	81 (33.1 %)	157 (42.7 %)	120 (36.5 %)
Not having family member infection of COVID-19	164 (66.9 %)	211 (57.3 %)	209 (63.5 %)
	Mean (SD)	Mean (SD)	Mean (SD)
Age	20.63 (1.54)	20.62 (1.69)	20.8 (1.56)

Note. CSSA = Comprehensive Social Security Assistance Scheme; FD_P = Personal Financial Difficulty; FU = Unemployment of Oneself or Family Members; COVID_IND = Personal Infection of COVID-19; COVID_FAM = Family Member Infection of COVID-19.

with the inclusion of socio-demographic correlates. CSSA, personal financial difficulty, unemployment of oneself and family members, and family members tested positive for COVID-19 had significant predictive effects while living status did not have significant effects. In specific, after controlling the effects of other predictors, compared to the likelihood in the "normal" group (Class 1, the reference class), personal financial difficulty ($B = 0.761$, $SE = 0.242$, $p < 0.01$, OR = 2.140, 95 % CI, 1.331–3.442) was 2.140 times higher than in the "severe comorbid depression and anxiety" group; and the likelihood of unemployment of

Table 6
Parameter estimates for the latent class model with covariates (univariate analysis).

Covariates	"severe comorbid depression and anxiety" group (Class 3) vs. "normal" group (Class 1, the reference class)					"moderate comorbid depression and anxiety" group (Class 2) vs. "normal" group (Class 1, the reference class)					"severe comorbid depression and anxiety" group (Class 3) vs. "moderate comorbid depression and anxiety" group (Class 2, the reference class)				
	B	*SE*	*p*	OR	95 %CI	*B*	*SE*	*p*	OR	95%CI	*B*	*SE*	*p*	OR	95%CI
Age	0.077	0.054	0.150	1.080	0.972–1.200	0.000	0.060	0.998	1.000	0.890–1.124	0.077	0.050	0.126	1.080	0.979–1.192
Gender	0.320	0.188	0.089	1.377	0.953–1.989	0.041	0.201	0.838	1.042	0.703–1.544	0.279	0.174	0.110	1.321	0.939–1.860
Year of Study	−0.045	0.109	0.680	0.956	0.773–1.183	−0.171	0.116	0.139	0.843	0.672–1.057	1.126	0.102	0.217	1.135	0.929–1.386
Local/International	−0.235	0.363	0.517	0.790	0.388–1.611	−0.106	0.375	0.777	0.899	0.431–1.876	−0.129	0.349	0.712	0.879	0.443–1.743
Living status	2.118	1.047	0.043	8.315	1.069–64.680	1.664	1.085	0.125	5.281	0.630–44.249	0.454	0.495	0.359	1.575	0.597–4.151
CSSA	1.464	0.503	0.004	4.323	1.614–11.578	0.084	0.644	0.131	1.088	0.308–3.846	1.379	0.464	0.003	3.973	1.601–9.857
FD_P	1.047	0.213	0.000	2.848	1.875–4.328	0.504	0.229	0.028	1.655	1.057–2.592	0.543	0.186	0.004	1.721	1.195–2.478
FU	1.004	0.257	0.000	2.728	1.648–4.515	0.613	0.269	0.023	1.845	1.088–3.128	0.391	0.201	0.051	1.478	0.998–2.191
COVID_IND	0.432	0.227	0.057	1.540	0.987–2.402	0.292	0.238	0.220	1.339	0.840–2.134	0.140	0.190	0.462	1.150	0.792–1.670
COVID_FAM	0.201	0.206	0.328	1.223	0.817–1.831	0.516	0.210	0.014	1.676	1.109–2.531	−0.315	0.171	0.066	0.730	0.522–1.021

Note. CSSA = Comprehensive Social Security Assistance Scheme; FD_*P* = Personal Financial Difficulty; FU = Unemployment of Oneself or Family Members; COVID_IND = Personal Infection of COVID-19; COVID_FAM = Family Member Infection of COVID-19.

Table 7
Parameter estimates for the latent class model with covariates (multivariate analysis).

Covariates	"severe comorbid depression and anxiety" group (Class 3) vs. normal group (Class 1, the reference class)					"moderate comorbid depression and anxiety" group (Class 2) vs. "normal" group (Class 1, the reference class)					Class 3 ("severe comorbid depression and anxiety" group (Class 3) vs. "moderate comorbid depression and anxiety" group (Class 2, the reference class)				
	B	*SE*	*p*	OR	95 %CI	*B*	*SE*	*p*	OR	95 %CI	*B*	*SE*	*p*	OR	95 %CI
Living status	1.530	1.042	0.142	4.618	0.600–35.570	1.426	1.081	0.187	4.160	0.500–34.603	0.104	0.535	0.845	1.110	0.389–3.165
CSSA	1.000	0.555	0.071	2.719	0.916–8.067	−0.243	0.697	0.727	0.784	0.200–3.071	1.243	0.477	0.009	3.468	1.361–8.835
FD_P	0.761	0.242	0.002	2.140	1.331–3.442	0.296	0.263	0.262	1.344	0.802–2.252	0.465	0.213	0.029	1.593	1.049–2.417
FU	0.594	0.282	0.035	1.811	1.042–3.148	0.476	0.291	0.102	1.610	0.910–2.848	0.118	0.228	0.605	1.125	0.720–1.758
COVID_FAM	0.070	0.227	0.759	1.072	0.687–1.673	0.449	0.233	0.054	1.566	0.992–2.473	−0.379	0.189	0.045	0.685	0.472–0.992

Note. CSSA = Comprehensive Social Security Assistance Scheme; FD_*P* = Personal Financial Difficulty; FU = Unemployment of Oneself or Family Members; COVID_IND = Personal Infection of COVID-19; COVID_FAM = Family Member Infection of COVID-19.

oneself or family members ($B = 0.594$, $SE = 0.282$, $p < 0.05$, OR = 1.811, 95 %CI, 1.042–3.148) was 1.811 times higher than in the "severe comorbid depression and anxiety" group. In addition, upon controlling the effect of other predictors, compared to the likelihood in the "moderate comorbid depression and anxiety" group (Class 2, the reference class), the likelihood of family receiving CSSA ($B = 1.243$, $SE = 0.477$, $p < 0.01$, OR = 3.468, 95 %CI, 1.361–8.835) was 3.468 times higher in the "severe comorbid depression and anxiety" group; the likelihood of personal financial difficulties ($B = 0.465$, $SE = 0.213$, $p < 0.05$, OR = 1.593, 95 %CI, 1.049–2.417) was 1.593 times higher in the "severe comorbid depression and anxiety" group; and the likelihood of having family members tested positive for COVID-19 ($B = -0.379$, $SE = 0.189$, $p < 0.05$, OR = 0.685, 95 %CI, 0.472–0.992) was 0.685 times higher in the "severe comorbid depression and anxiety" group.

4. Discussion

4.1. Latent class groups on symptoms of anxiety and depression in university students

The present study examined the profiles of symptoms of anxiety and depression in a sample ($N = 987$) of undergraduate students in Hong Kong using latent class analyzes. Its aim was to identify the heterogeneity (subgroups) in the sample on symptoms of anxiety and depression, which adopted a person-centered approach instead of a variable-centered approach in normal data analytical techniques. The study identified three latent classes (subgroups) that had distinctive characteristics of symptoms of anxiety and depression: Class 1 represented students with a normal level of anxiety and depression, Class 2 comprised students with moderate levels of anxiety and depression, and Class 3 consisted of students with severe levels of anxiety and depression. The findings have significant implications for the existing literature. First, most of the extant literature on mental health issues in university students during the pandemic adopted a variable-centered approach which focused on examining the prevalence or status of mental health problems or psychological morbidity based on individual variables (Faisal et al., 2022; Lopes and Nihei, 2021; Zhou et al., 2021). There is quite limited research adopting a person-centered approach to examine subgroups in the university student population based on a set of mental health problems, particularly on the comorbid patterns of anxiety and depression. The three latent class groups identified in the present study indicated the high comorbidity of anxiety and depression symptoms as there was no group with high anxiety and low depression or with low anxiety and high depression. This was in line with other limited existing empirical studies on comorbidity patterns of anxiety and depression using LCA, which showed a high association between anxiety and depression in university students (van Lang et al., 2006; Liu et al., 2021; Wadsworth et al., 2001). Altogether, the findings of the study contribute to the literature on student subgroups with different comorbid patterns of anxiety and depression in university students under the pandemic. The findings also contribute to designing better intervention and prevention programs targeting student subgroups with different comorbid patterns of anxiety and depression (van Lang et al., 2006; Peterson et al., 2019).

4.2. Socio-demographic correlates of latent class groups of anxiety and depression

Results of the univariate and multivariate logistic regression in LCA with socio-demographic correlates showed that economic problems or financial difficulties had significant predictive effects on the latent class groups. Particularly, compared with the "normal" group and the "moderate symptom" group, the "severe symptom" group had a significantly higher probability of having personal financial problems, problems of unemployment of oneself or family members, or being in a family receiving CSSA. Nevertheless, no significant difference was observed between the "normal" group and the "severe symptom" group on all other socio-demographic factors. The results contribute significantly to the existing literature. While there has been a body of research on socio-demographic factors related to anxiety and depressive symptoms in university students under COVID-19 (e.g., Chen and Lucock 2022; Lopes and Nihei 2021; Saadeh et al. 2021), the studies mainly adopted a variable-centered approach so there is no research identifying socio-demographic risk factors to subgroups of university students on symptoms of comorbid anxiety and depression under the pandemic. The results of the present study indicate that financial difficulties or problems would be a significant risk factor for subgroups of students with different levels of comorbid anxiety and depression in university students as they significantly differentiated the "severe symptom" group from the "normal" and "moderate symptom" group. The findings were also consistent with the existing studies based on a variable-centered approach showing that financial difficulties significantly and positively predicted anxiety and depression among students in higher education institutions under COVID-19 (Eisenberg et al., 2007; Galanza et al., 2023). The findings provide important information that can contribute to enhanced intervention and prevention strategies for addressing mental health issues among university students during the pandemic through identifying risk groups who were experiencing financial difficulties, unemployment, or in families with low socioeconomic status.

With regard to the predictive effects of age, gender, year of study, and living status, interestingly, the results of this study showed that the three latent class groups did not differ in these factors. This is inconsistent with some of the existing studies on the significant predictive effects of these socio-demographic factors on anxiety and depression in university students under the pandemic (e.g., Chen and Lucock 2022; Chi et al. 2020; Dhar et al. 2020). One reason for the inconsistent findings might be due to the different predictive effects of these socio-demographic factors on depression and anxiety. For example, some studies found that while gender significantly predicted anxiety (females had higher anxiety than males) (Muzaffar et al., 2022), it did not predict depression in university students (Chen et al., 2013; Eisenberg et al., 2007). Also, there were studies showing that gender did not predict both anxiety and depression in university students (Islam et al., 2020; Ramón-Arbués et al., 2020). With regard to year of study, while some of the existing studies showed that lower-year students had higher levels of anxiety and depression (Bayram and Bilgel, 2008), some studies revealed that higher-year students demonstrated higher levels of anxiety and depression (Yu et al., 2021). Under the specific circumstances of the pandemic, both junior and senior year students might face significant challenges and pressures; therefore, their level of mental health problems might not have significant differences.

Furthermore, the study found a non-significant effect of family member infection of COVID-19 on latent class groups with different profiles of anxiety and depression. This is inconsistent with many existing research based on a variable-centered approach which showed a significant positive association between family member infection and mental health problems such as anxiety and depression (Cao et al., 2020; Wang et al., 2020). One possible explanation of the result might be due to different periods of the pandemic in which the study was conducted and different government policies on the pandemic. For example, the study of Cao et al. (2020) and Wang et al. (2020) were all based on college students in mainland China at "the early outbreak peak of COVID-19 in China" during which people would have higher pressure and fear regarding infection with COVID-19 (Cao et al., 2020); therefore, the family member infection might have higher chance to trigger mental health problems during this period. However, the present study was based on data in the summer of 2022 which was around the middle period of the fifth wave of the pandemic in Hong Kong; during that time, the infection rate of the virus had already dropped significantly, and the people has already had rich knowledge about the pandemic (Lung et al., 2022). Besides, the lethality of the Omicron strain is much lower than

those of the earlier strains. Therefore, having family members being infected might not be a high stressor that would lead to mental health problems in university students.

Despite the innovative nature of the study, it is imperative to note several limitations. First, while quota sampling adopted in this study is cost-effective and it was commonly adopted in different studies under the pandemic due to difficulties of recruiting study participants (e.g., Bautista-Díaz et al. 2023; McBride et al. 2021), it is a non-probability sampling which could not make generalization of the results (Iliyasu and Etikan, 2021). Future research should be conducted based on the method of random sampling. Second, the participants were mainly recruited from one university. Future research should be conducted based on the participants from multiple universities to replicate the results. Third, the self-report measures were employed in the study which may be biased due to the social desirability (Tanaka-Matsumi and Kameoka, 1986). Other approaches to assessing anxiety and depression such as structured psychiatric interviews based on depressive episodes could be employed in future research.

In conclusion, using LCA, this study identified three subgroups with different characteristics of depressive and anxiety symptoms. The first group was characterized by lower percentages of having the most depressive and anxiety symptoms. The second group was characterized by middle to high percentages of having depressive and anxiety symptoms. The third group was characterized by extremely high percentages of having the most depressive and anxiety symptoms. This study also suggests that economic or financial difficulty would be a high-risk factor for identifying subgroups with high levels of depression and anxiety. Despite the limitations, this study contributes significantly to the understanding of subgroups of university students with different comorbidity patterns of anxiety and depression during the pandemic, which also sheds light on more effective interventions and prevention of anxiety and depression. Future research could go further to include other mental health indicators that have high comorbidity with depression and anxiety in the LCA such as stress symptoms assessed in the DASS scale to deepen the understanding of the subgroup characteristics. In addition, future research could go further to examine the potential COVID-19-related risk factors for subgroups with person-centered characteristics of depression and anxiety symptoms.

CRediT authorship contribution statement

Wenyu Chai: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Daniel T.L. Shek:** Conceptualization, Supervision, Funding acquisition, Project administration, Writing – review & editing.

Declaration of Competing Interest

All authors declare that they have no conflicts of interest.

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References

Ahmadi-Montecalvo, H., Lilly, C.L., Zullig, K.J., Cottrell, L.A., Dino, G.A., 2019. A latent class analysis of the co-occurrence of risk behaviors among adolescents. Am. J. Health Behav. 43, 449–463. https://doi.org/10.5993/AJHB.43.3.1.

Bantjes, J., Hunt, X., Stein, D.J., 2022. Public health approaches to promoting university students’ mental health: a global perspective. Curr. Psychiatry Rep. 24, 809–818. https://doi.org/10.1007/s11920-022-01387-4.

Bashir, M.F., Ma, B., Shahzad, L., 2020. A brief review of socio-economic and environmental impact of COVID-19. Air Qual. Atmos. Health 13, 1403–1409. https://doi.org/10.1007/s11869-020-00894-8.

Bautista-Díaz, M.L., Filio-Flores, A.Y., Maldonado-Castañón, G., Martínez-Montes, M., 2023. Detection of psychological needs in university students due to confinement during the third wave of COVID-19 pandemic. J. Appl. Psychol. 4, 14–18. https://doi.org/10.29057/jbapr.v4i8.9054.

Bayram, N., Bilgel, N., 2008. The prevalence and sociodemographic correlates of depression, anxiety, and stress among a group of university students. Soc. Psychiatry Psychiatr. Epidemiol. 43, 667–672. https://doi.org/10.1007/s00127-008-0345-x.

Beijers, L., Wardenaar, K.J., Bosker, F.J., Lamers, F., van Grootheest, G., de Boer, M.K., Brenda, W.J.H., Schoevers, R.A., 2019. Biomarker-based subtyping of depression and anxiety disorders using Latent Class Analysis. A NESDA study. Psychol. Med. 49, 617–627. https://doi.org/10.1017/S0033291718001307.

Beiter, R., Nash, R., McCrady, M., Rhoades, D., Linscomb, M., Clarahan, M., Sammut, S., 2015. The prevalence and correlates of depression, anxiety, and stress in a sample of college students. J. Affect. Disord. 173, 90–96. https://doi.org/10.1016/j.jad.2014.10.054.

Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., Zheng, J., 2020. The psychological impact of the COVID-19 epidemic on college students in China. Psychiatry Res. 287, 112934 https://doi.org/10.1016/j.psychres.2020.112934.

Cao, Y., Siu, J.Y.M., Shek, D.T.L., Shum, D.H., 2022. COVID-19 one year on: identification of at-risk groups for psychological trauma and poor health-protective behaviour using a telephone survey. BMC Psychiatry 22, 1–16. https://doi.org/10.1186/s12888-022-03904-4.

Chen, T., Lucock, M., 2022. The mental health of university students during the COVID-19 pandemic: an online survey in the UK. PLoS One 17, e0262562. https://doi.org/10.1371/journal.pone.0262562.

Chen, L., Wang, L., Qiu, X.H., Yang, X.X., Qiao, Z.X., Yang, Y.J., Liang, Y., 2013. Depression among Chinese university students: prevalence and socio-demographic correlates. PLoS One 8, e58379. https://doi.org/10.1371/journal.pone.0058379.

Cheung, K., Tam, K.Y., Tsang, M.H., Zhang, L.W., Lit, S.W., 2020. Depression, anxiety and stress in different subgroups of first-year university students from 4-year cohort data. J. Affect. Disord. 274, 305–314. https://doi.org/10.1016/j.jad.2020.05.041.

Chi, X., Becker, B., Yu, Q., Willeit, P., Jiao, C., Huang, L., Hossain, M.M., Gravovac, I., Yeung, A., Lin, J., Veronese, N., Wang, J., Zhou, X., Doig, S.R., Liu, X., Carvalho, A. F., Yang, L., Xiao, T., Zou, L., Fusar-Poli, P., Solmi, M., 2020. Prevalence and psychosocial correlates of mental health outcomes among Chinese college students during the coronavirus disease (COVID-19) pandemic. Front. Psychiatry 11, 803. https://doi.org/10.3389/fpsyt.2020.00803.

Chu, W.Y., 2021. Explore the financial stress and its influences on academic study and the health of universities students in Hong Kong. Thesis. The Education University of Hong Kong. https://repository.eduhk.hk/en/publications/explore-the-financial-stress-and-its-influences-on-academic-study.

Crawford, J.R., Henry, J.D., 2003. The depression anxiety stress scale (DASS): normative data and latent structure in a large non-clinical sample. Br. J. Clin. Psychol. 42, 111–131. https://doi.org/10.1348/014466503321903544.

Cummings, C.M., Caporino, N.E., Kendall, P.C., 2014. Comorbidity of anxiety and depression in children and adolescents: 20 years after. Psychol. Bull. 140, 816–845. https://doi.org/10.1037/a0034733.

Debowska, A., Horeczy, B., Boduszek, D., Dolinski, D., 2020. A repeated cross-sectional survey assessing university students’ stress, depression, anxiety, and suicidality in the early stages of the COVID-19 pandemic in Poland. Psychol. Med. 52, 3744–3747. https://doi.org/10.1017/S003329172000392X.

Dhar, B.K., Ayittey, F.K., Sarkar, S.M., 2020. Impact of COVID-19 on psychology among the university students. Global Chall. 4, 2000038 https://doi.org/10.1002/gch2.202000038.

Dosil-Santamaria, M., Ozamiz-Etxebarria, N., Idoiaga Mondragon, N., Reyes-Sosa, H., Santabárbara, J., 2022. Emotional state of Mexican university students in the COVID-19 pandemic. Int. J. Environ. Res. Public Health 19, 2155. https://doi.org/10.3390/ijerph19042155.

Eisenberg, D., Gollust, S.E., Golberstein, E., Hefner, J.L., 2007. Prevalence and correlates of depression, anxiety, and suicidality among university students. Am. J. Orthopsychiatry 77, 534–542. https://doi.org/10.1037/0002-9432.77.4.534.

ElTohamy, A., Hyun, S., Macaranas, A.R., Chen, J.A., Stevens, C., Liu, C.H., 2022. Testing positive, losing a loved one, and financial hardship: real-world impacts of COVID-19 on US college student distress. J. Affect. Disord. 314, 357–364. https://doi.org/10.1016/j.jad.2022.07.022.

Essau, C.A., de la Torre-Luque, A., 2019. Comorbidity profile of mental disorders among adolescents: a latent class analysis. Psychiatry Res. 278, 228–234. https://doi.org/10.1016/j.psychres.2019.06.007.

Esteves, C.S., Oliveira, C.R.D., Argimon, I.I.D.L., 2021. Social distancing: prevalence of depressive, anxiety, and stress symptoms among Brazilian students during the COVID-19 pandemic. Front. Public Health 8, 589966. https://doi.org/10.3389/fpubh.2020.589966.

Faisal, R.A., Jobe, M.C., Ahmed, O., Sharker, T., 2022. Mental health status, anxiety, and depression levels of Bangladeshi university students during the COVID-19 pandemic. Int. J. Ment. Health Addict. 20, 1500–1515. https://doi.org/10.1007/s11469-020-00458-y.

Ferdinand, R.F., de Nijs, P.F.A., van Lier, P., Verhulst, F.C., 2005. Latent class analysis of anxiety and depressive symptoms in referred adolescents. J. Affect. Disord. 88, 299–306. https://doi.org/10.1016/j.jad.2005.08.004.

Galanza, M.A.M.C., Aruta, J.J.B.R., Mateo, N.J., Resurreccion, R.R., Bernardo, A.B., 2023. Mental health of Filipino university students during the COVID-19 pandemic: the distinct associations of fear of COVID-19 and financial difficulties. Educ. Dev. Psychol. 40, 125–130. https://doi.org/10.1080/20590776.2021.1999168.

Garber, J., Weersing, V.R., 2010. Comorbidity of anxiety and depression in youth: implications for treatment and prevention. Clin. Psychol. Sci. Pract. 17, 293–306. https://doi.org/10.1111/j.1468-2850.2010.01221.x.

Ghazawy, E.R., Ewis, A.A., Mahfouz, E.M., Khalil, D.M., Arafa, A., Mohammed, Z., Mohammed, E.F., Hassan, E.E., Hamid, S.A., Ewis, S.A., Mohammed, A.E.N.S., 2021. Psychological impacts of COVID-19 pandemic on the university students in Egypt. Health Promot. Int. 36, 1116–1125. https://doi.org/10.1093/heapro/daaa147.

Hutchesson, M.J., Duncan, M.J., Oftedal, S., Ashton, L.M., Oldmeadow, C., Kay-Lambkin, F., Whatnall, M.C., 2021. Latent class analysis of multiple health risk behaviors among Australian university students and associations with psychological distress. Nutrients 13, 425. https://doi.org/10.3390/nu13020425.

Iliyasu, R., Etikan, I., 2021. Comparison of quota sampling and stratified random sampling. Biom. Biostat. Int. J. 10, 24–27.

Islam, S., Akter, R., Sikder, T., Griffiths, M.D., 2020. Prevalence and factors associated with depression and anxiety among first-year university students in Bangladesh: a cross-sectional study. Int. J. Ment. Health Addict. 20, 1289–1302. https://doi.org/10.1007/s11469-020-00242-y.

Jadoon, N.A., Yaqoob, R., Raza, A., Shehzad, M.A., Zeshan, S.C., 2010. Anxiety and depression among medical students: a cross-sectional study. J. Pak. Med. Assoc. 60, 699–702.

Johnson, C.V., 2009. A process-oriented group model for university students: a semi-structured approach. Int. J. Group Psychother. 59, 511–528. https://doi.org/10.1521/ijgp.2009.59.4.511.

Kim, S., Wong, A.K.F., Han, H., Yeung, M.W., 2022. How does the COVID-19 pandemic influence travel industry employees in Hong Kong? Structural relationships among airline crew's job-related stressors, mental health and other consequences. Asia Pac. J. Tour. Res. 27, 69–85. https://doi.org/10.1080/10941665.2021.1998161.

Lakhan, R., Agrawal, A., Sharma, M., 2020. Prevalence of depression, anxiety, and stress during COVID-19 pandemic. J. Neurosci. Rural Pract. 11, 519–525. https://doi.org/10.1055/s-0040-1716442.

Lanza, S.T., Cooper, B.R., 2016. Latent class analysis for developmental research. Child Dev. Perspect. 10, 59–64. https://doi.org/10.1111/cdep.12163.

Lei, H., Chen, C., Hagiwara, K., Kusumi, I., Tanabe, H., Inoue, T., Nakagawa, S., 2022. Symptom patterns of the occurrence of depression and anxiety in a Japanese general adult population sample: a latent class analysis. Front. Psychol. 13, 808918 https://doi.org/10.3389/fpsyt.2022.808918.

Li, X., Shek, D.T.L., Shek, E.Y., 2021. Psychological morbidity among university students in Hong Kong (2014-2018): psychometric properties of the Depression Anxiety Stress Scales (DASS) and related correlates. Int. J. Environ. Res. Public Health 18, 8305. https://doi.org/10.3390/ijerph18168305.

Liu, Z., Liu, R., Zhang, Y., Zhang, R., Liang, L., Wang, Y., Wei, Y., Zhu, R., Wang, F., 2021. Latent class analysis of depression and anxiety among medical students during COVID-19 epidemic. BMC Psychiatry 21, 1–10. https://doi.org/10.1186/s12888-021-03459-w.

Lopes, A.R., Nihei, O.K., 2021. Depression, anxiety and stress symptoms in Brazilian university students during the COVID-19 pandemic: predictors and association with life satisfaction, psychological well-being and coping strategies. PLoS One 16, e0258493. https://doi.org/10.1371/journal.pone.0258493.

Lovibond, P.F., Lovibond, S.H., 1995. The structure of negative emotional states: comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. Behav. Res. Ther. 33, 335–343. https://doi.org/10.1016/0005-7967(94)00075-U.

Lu, S., Hu, S., Guan, Y., Xiao, J., Cai, D., Gao, Z., Sang, Z., Wei, J., Zhang, X., Margraf, J., 2018. Measurement invariance of the Depression Anxiety Stress Scale-21 across gender in a sample of Chinese university students. Front. Psychol. 9, 2064. https://doi.org/10.3389/fpsyg.2018.02064.

Lung, D.C., Hung, I.F., Sridhar, S., Yuen, K., 2022. Beyond Hong Kong's Covid-19 Fifth Wave: Coping with the Coronavirus. AsiaGlobal Online, Asia Global Institute, The University of Hong Kong. https://www.asiaglobalonline.hku.hk/beyond-hong-kongs-covid-19-fifth-wave-coping-coronavirus.

Luo, W., Zhong, B.L., Chiu, H.F.K., 2021. Prevalence of depressive symptoms among Chinese university students amid the COVID-19 pandemic: a systematic review and meta-analysis. Epidemiol. Psychiatr. Sci. 30, e31. https://doi.org/10.1017/S2045796021000202.

McBride, O., Murphy, J., Shevlin, M., Gibson-Miller, J., Hartman, T.K., Hyland, P., Levita, L., Mason, L., Martinez, A.P., McKay, R., VA Stocks, T., Bennett, K.M., Vallieres, F., Karatzias, T., Valiente, C., Vazquez, C., Bentall, R.P., 2021. Monitoring the psychological, social, and economic impact of the COVID-19 pandemic in the population: context, design and conduct of the longitudinal COVID-19 psychological research consortium (C19PRC) study. Int. J. Methods Psychiatr. Res. 30, e1861. https://doi.org/10.1002/mpr.1861.

Moussa, M.T., Lovibond, P., Laube, R., Megahead, H.A., 2017. Psychometric properties of an Arabic version of the depression anxiety stress scale (DASS). Res. Soc. Work Pract. 27, 375–386. https://doi.org/10.1177/1049731516662916.

Muzaffar, R., Koly, K.N., Choudhury, S., Biswas, M.A.A.J., Kader, S.B., Abdullah, R., Kawser, U., Hasan, M.T., Williams, D., Chowdhury, A.B., Ahmed, H.U., 2022. Generalized anxiety disorder among Bangladeshi university students during COVID-19 pandemic: gender specific findings from a cross-sectional study. Discov. Ment. Health 2, 3. https://doi.org/10.1007/s44192-022-00005-2.

Nassr, R.M., Aborujilah, A., Aldossary, D.A., Aldossary, A.A.A., 2020. Understanding educational difficulty during COVID-19 lockdown: reports on Malaysian university students' experience. IEEE Access 8, 186939–186950. https://doi.org/10.1109/ACCESS.2020.3029967.

Nylund-Gibson, K., Choi, A.Y., 2018. Ten frequently asked questions about latent class analysis. Transl. Issues Psychol. Sci. 4, 440. https://doi.org/10.1037/tps0000176.

Pat-Horenczyk, R., Schiff, M., Arenliu, A., Zasiekina, L., Kagialis, A., Ferreira, N., Nesterko, Y., Glaesmer, H., Fernandez-Alcantara, M., Benbenishty, R., 2022. Challenges faced by university students during the COVID-19: an international study in five countries during the early phase of the pandemic. Int. J. Psychol. 57, 547–558. https://doi.org/10.1002/ijop.12846.

Pavlova, I., Zikrach, D., Shvets, V., Petrytsa, P., Ortenburger, D., Langfort, J., 2022. Profiles of academic motivation and wellbeing of physical education and sports instructors of internal affairs establishments: a person-centered approach based on self-determination theory. Phys. Act. Rev. 10, 1–11. https://doi.org/10.16926/par.2022.10.16.

Peterson, K.J., Qualter, P., Humphrey, N., 2019. The application of latent class analysis for investigating population child mental health: a systematic review. Front. Psychol. 10, 1214. https://doi.org/10.3389/fpsyg.2019.01214.

Pietrabissa, G., Simpson, S.G., 2020. Psychological consequences of social isolation during COVID-19 outbreak. Front. Psychol. 11, 2201. https://doi.org/10.3389/fpsyg.2020.02201.

Ramón-Arbués, E., Gea-Caballero, V., Granada-López, J.M., Juárez-Vela, R., Pellicer-García, B., Antón-Solanas, I., 2020. The prevalence of depression, anxiety and stress and their associated factors in college students. Int. J. Environ. Res. Public Health 17, 7001. https://doi.org/10.3390/ijerph17197001.

Saadeh, H., Saadeh, M., Almobaideen, W., Al Refaei, A., Shewaikani, N., Al Fayez, R.Q., Khawaldah, H., Abu-Shanab, S., Al-Hussaini, M., 2021. Effect of COVID-19 quarantine on the sleep quality and the depressive symptom levels of university students in Jordan during the spring of 2020. Front. Psychiatry 12, 605676. https://doi.org/10.3389/fpsyt.2021.605676.

Salari, N., Hosseinian-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulpoor, S., Mohammadi, M., Rasoulpoor, S., Khaledi-Paveh, B., 2020. Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. Glob. Health 16, 57. https://doi.org/10.1186/s12992-020-00589-w.

Schiff, M., Zasiekina, L., Pat-Horenczyk, R., Benbenishty, R., 2021. COVID-related functional difficulties and concerns among university students during COVID-19 pandemic: a binational perspective. J. Community Health 46, 667–675. https://doi.org/10.1007/s10900-020-00930-9.

Sestito, L.A., Sica, L.S., Ragozini, G., Porfeli, E., Weisblat, G., Di Palma, T., 2015. Vocational and overall identity: a person-centered approach in Italian university students. J. Vocat. Behav. 91, 157–169. https://doi.org/10.1016/j.jvb.2015.10.001.

Shek, D.T.L., Dou, D., Zhu, X., 2022a. Prevalence and correlates of mental health of university students in Hong Kong: what happened one year after the occurrence of COVID-19? Front. Public Health 10, 857147. https://doi.org/10.3389/fpubh.2022.857147.

Shek, D.T.L., Dou, D., Zhu, X., Wong, T., Tan, L., 2022b. Need satisfaction and depressive symptoms among university students in Hong Kong during the COVID-19 pandemic: moderating effects of positive youth development attributes. Front. Psychol. 13, 931404 https://doi.org/10.3389/fpsyt.2022.931404.

Shek, D.T.L., Chai, W., Li, X., Dou, D., 2023. Profiles and predictors of mental health of university students in Hong Kong under the COVID-19 pandemic. Front. Psychol. 14, 1211229 https://doi.org/10.3389/fpsyg.2023.1211229.

Shek, D.T.L., Zhao, L., Dou, D., Zhu, X., Xiao, C., 2021. The impact of positive youth development attributes on posttraumatic stress disorder symptoms among Chinese adolescents under COVID-19. J. Adolesc. Health 68, 676–682. https://doi.org/10.1016/j.jadohealth.2021.01.011.

Sinha, P., Calfee, C.S., Delucchi, K.L., 2021. Practitioner's guide to latent class analysis: methodological considerations and common pitfalls. Crit. Care Med. 49, e63–e79. https://doi.org/10.1097/CCM.0000000000004710.

Scotto Rosato, N., Baer, J.C., 2012. Latent class analysis: a method for capturing heterogeneity. Soc. Work Res. 36, 61–69. https://doi.org/10.1093/swr/svs006.

Tanaka-Matsumi, J., Kameoka, V.A., 1986. Reliabilities and concurrent validities of popular self-report measures of depression, anxiety, and social desirability. J. Consult. Clin. Psychol. 54, 328. https://doi.org/10.1037/0022-006X.54.3.328.

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. Behav. Res. Ther. 44, 849–860. https://doi.org/10.1016/j.brat.2005.06.004.

Veltman, E.M., Lamers, F., Comijs, H.C., De Waal, M.W.M., Stek, M.L., Van der Mast, R. C., Rhebergen, D., 2017. Depressive subtypes in an elderly cohort identified using latent class analysis. J. Affect. Disord. 218, 123–130. https://doi.org/10.1016/j.jad.2017.04.059.

Vermunt, J.K., Magidson, J., 2004. Latent class analysis. Lewis-Beck, M., Bryman, A., Liao, T.F. (Eds.). The Sage Encyclopedia of Social Sciences Methods. Sage, Thousand Oakes, pp. 549–553.

Wadsworth, M.E., Hudziak, J.J., Heath, A.C., Achenbach, T.M., 2001. Latent class analysis of child behavior checklist anxiety/depression in children and adolescents. J. Am. Acad. Child Adolesc. Psychiatry 40, 106–114. https://doi.org/10.1097/00004583-200101000-00023.

Wang, C., Wen, W., Zhang, H., Ni, J., Jiang, J., Cheng, Y., Zhou, M., Ye, L., Feng, Z., Ge, Z., Luo, H., Wang, M., Zhang, X., Liu, W., 2021. Anxiety, depression, and stress prevalence among college students during the COVID-19 pandemic: a systematic review and meta-analysis. J. Am. Coll. Health 1–8. https://doi.org/10.1080/07448481.2021.1960849.

Wang, Z.H., Yang, H.L., Yang, Y.Q., Liu, D., Li, Z.H., Zhang, X.R., Zhang, Y.J., Shen, D., Chen, P.L., Song, W.Q., Wang, X.M., Wu, X.B., Yang, X.F., Mao, C., 2020. Prevalence of anxiety and depression symptom, and the demands for psychological knowledge and interventions in college students during COVID-19 epidemic: a large cross-sectional study. J. Affect. Disord. 275, 188–193. https://doi.org/10.1016/j.jad.2020.06.034.

Weller, B.E., Bowen, N.K., Faubert, S.J., 2020. Latent class analysis: a guide to best practice. J. Black Psychol. 46, 287–311. https://doi.org/10.1177/0095798420930932.

Wong, W., Chu, M., 2017. Rebel with a cause: structural problems underlying the Umbrella Movement of Hong Kong and the role of the youth. Asian Educ. Dev. Stud. 6, 343–353. https://doi.org/10.1108/AEDS-11-2015-0058.

Yu, M., Tian, F., Cui, Q., Wu, H., 2021. Prevalence and its associated factors of depressive symptoms among Chinese college students during the COVID-19 pandemic. BMC Psychiatry 21, 1–8. https://doi.org/10.1186/s12888-021-03066-9.

Zhou, S.J., Wang, L.L., Qi, M., Yang, X.J., Gao, L., Zhang, S.Y., Zhang, L.G., Yang, R., Chen, J.X., 2021. Depression, anxiety, and suicidal ideation in Chinese university students during the COVID-19 pandemic. Front. Psychol. 12, 669833 https://doi.org/10.3389/fpsyg.2021.669833.