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ABSTRACT

Objectives: There has been increasing attention to adverse childhood experiences (ACEs) among adolescents in the U.S because ACEs may result in severe mental health issues. Although associations between ACEs and mental health have been explored, research on how different types or combinations of ACEs render different impacts on adolescents is limited. Therefore, this study aims to (a) examine latent classes of ACEs among adolescents who have experienced at least one ACE and (b) investigate associations of each latent group of ACEs with mental health problems, depression and anxiety.

Method: Questionnaires on ACEs and depression/anxiety from the 2016 National Survey of Children's Health (NSCH) were used, and a total of 11,437 adolescents aged 10–17 years were included in this study. For analyses, latent class analysis (LCA) was implemented to identify the number and types of classes, which are pertinent to represent the heterogenous combinations of ACEs. Moreover, chi-square tests and ordinal regression were performed to investigate the associations of class memberships within ACEs with depression/anxiety.

Results: The LCA found four class memberships within ACEs: Multiple High-Risk, Broken Family, Income Hardship, and Multiple Low-Risk. These classes displayed differences in depression/anxiety. For both pre-existing and current conditions of depression/anxiety, the most prominence has been found in the Multiple High- Risk, followed by the Multiple Low-Risk, the Broken Family, and the Income Hardship, in

order.

Conclusions: These differences among the classes indicate that understanding of ACEs and interventions should be based on considering latent classes of ACEs.

Introduction

There is a growing interest in the role of mental health professionals and clinicians in treating adverse childhood experiences (ACEs) and mental health difficulties. In the U.S, cross-sectional and longitudinal studies on children and adolescents experiencing harmful acts of physical, emotional, and socio-environmental influences such as neighborhood violence or drug use have been underway (e.g., NSCH, LONGSCAN). Researchers examining the impact of ACEs have found adolescents to experience a number of challenges within the context of K-12 settings (Bethell, Newacheck, Hawes, & Halfon, 2014; Moore & Ramirez, 2016; Porche, Costello, & Rosen-Reynoso, 2016). Such challenges include dysregulation of emotion (Bradley et al., 2011), externalized behavior problems (Hazen, Connelly, Roesch, Hough, & Landsverk, 2009), and a lower degree of academic performance in school (Bethell et al., 2014). Simultaneously, an extensive body of work has discussed school-related mental health difficulties, specifically adolescents' emotional and behavioral disorders and its relevant school- based interventions (Reinke, Stormont, Herman, Puri, & Goel, 2011). Researchers have identified adolescents with mental health concerns to confront a number of challenges during developmental stages. These challenges, as are the consequences of ACEs, include dysregulation of emotions, externalized behavioral disorders, and lower levels of academic achievement (Bond et al., 2007; Patel, Flisher, Hetrick, & McGorry, 2007).

Despite these common negative consequences, less is known about the association between adolescents' ACEs and mental health concerns. Nevertheless, there is reason to believe that the association may be linked to different symptoms in mental health concerns, given no all ACEs adolescents are the same and heterogeneity within the population with ACEs. Further, such different combinations of adverse experiences may be associated with to some extent of mental health concerns. Yet

little is known about how adolescents' adverse childhood experiences reflect to the mental health status and to the degree of mental health symptoms adolescents attribute this. In this study, we examine the nature of the combinations of various ACEs. Moreover, we examine how adolescents' ACEs are associated with their depression and anxiety problems.

Literature review

ACEs refer to stressful or traumatic events exposed during childhood (Brown et al., 2009; Felitti et al., 1998). Felitti et al. (1998) devised ACEs inventory to measure children's and adolescents' adverse child- hood experiences. In their study, ACEs were categorized into two dimensions: (a) abuse and (b) household dysfunction. Abuse dimension included physical, psychological, and sexual abuse. A household dysfunction dimension refers to family dysfunction that can undermine children's safety and stability, such as mother treated violently, sub- stance abuse, mental illness, and incarcerated member in the household.

Although Felitti et al. (1998) study has been recognized as the original ACE study, a variety of ACE measures have been discussed and used by researchers with adaptations of the ACE inventory (e.g., Cronholm et al., 2015; Finkelhor, Shattuck, Turner, & Hamby, 2013; Wade, Shea, Rubin, & Wood, 2014). For example, Finkelhor et al. (2013) revised ACE scale, by putting an emphasis on the experience of victimization and exposure to violence (e.g., property and peer victimization, community violence). Cronholm et al. (2015) also expanded conventional ACE items into environmental adversities, such as living in foster care, witnessing violence, and unsafe neighborhood. For an- other, the National Survey of Children Health (NSCH) assessed adverse childhood experience primarily focusing on family dysfunction, with some part of direct experiences of maltreatment. In particular, NSCH collected adolescents' income hardship, community violence, and racial discrimination, beyond the original ACE items.

Since the ACE study, an extensive body of work has focused on ACEs, given that 66% of Americans are exposed to at least one type of ACEs with another 12% being exposed to more than four types of ACEs (Dube et al., 2001). Indeed, these experiences have shown short-term and long-term consequences (i.e., their life in

adulthood). That is, exposure to traumatic events during childhood may have a negative impact on developmental stages and increase the prevalence of behavioral risks into adulthood (Dube, Felitti, Dong, Giles, & Anda, 2003; Felitti et al., 1998). In this context, previous work about ACEs has examined the associations with health risks (Lanier, Maguire-Jack, Lombardi, Frey, & Rose, 2018), school-success related factors (Balistreri, 2015), health care support (Lanier, Maguire-Jack, & Welch, 2015), and mental health concerns (Briggs & Price, 2009; Chapman, Dube, & Anda, 2007). Nevertheless, research about whether ACEs may be linked to the development of mental health concerns (e.g., depression, anxiety problems, Autism, and ADHD) has not yet been fully explored.

While a number of mental health concerns have been identified in general, most prominent and prevalent problems in adolescents have been found to be depression and anxiety problem (Cummings, Caporino, & Kendall, 2014; Kieling et al., 2011; Mojtabai, Olfson, & Han, 2016). Depression, referring to persistent depressive disorder (Cummings et al., 2014), has been found to be often comorbid with other mental health disorders, such as anxiety disorder (Essau, 2003, 2008). Indeed, people who have been diagnosed with depression in their adolescence may show more maladaptive school engagement and troublesome interpersonal relationships with peers and teachers (Lewinsohn, Gotlib, Lewinsohn, Seeley, & Allen, 1998). In addition to these challenges, adolescents with depressive symptoms are often troubled by persistent feelings of sadness, show indifferent or aggressive behaviors to others, and have low levels of self-esteem. These depressive symptoms are not transitory nor restricted to their adolescence, and may continue to influence their lives into adulthood, or lead to suicidal thoughts (Kandel, Raveis, & Davies, 1991).

Anxiety disorder, a common psychological disorder observed in adolescents (Costello, Egger, & Angold, 2005; Merikangas et al., 2010), co-occurs with other psychological disorders, especially those with depressive symptoms (Essau, 2003, 2008). Anxiety disorder has been found to significantly impact an individuals' cognition, interpersonal and social functioning, and physical health (Teubert & Pinquart, 2011). Essau, Lewinsohn, Olaya, and Seeley (2014) further found that anxiety disorder in adolescence is associated more with adverse psychosocial outcomes in adulthood, as

compared to those in childhood.

Prior work consistently reported ACEs as risk factors of depression and anxiety disorder, and most of the studies have used cumulative index of ACEs. Specifically, individuals with ACEs in their childhood or adolescence are more likely to suffer from either depressive symptoms or anxiety problems, or their combination (Afifi et al., 2008; Chapman et al., 2004; McLaughlin et al., 2010) or even persistent ideation of suicide across their lifespan (Dube et al., 2001). While this approach has advantages, such as convenience and simplicity, it fails to provide heterogeneity of risk experiences associated with depression and anxiety (Barboza, 2018). Thus, a line of studies recently adopted a pat- tern-based approach (e.g., latent class analysis) to address the limitation (Barboza, 2018; Lanier et al., 2018; Stemple, Cox-Martin, Bronsert, Dickinson, & Allison, 2017; Wolff, Cuevas, Intravia, Baglivio, & Epps, 2018).

Despite prior research pronouncing LCA is informative providing information about the typologies of ACEs, what is missing from the literature is a more precise analysis targeted to at-risk youth population (Wolff et al., 2018). Previous studies that employed LCA usually identified a class named as 'normative' or 'No ACE' because they included those who did not report any ACEs. For example, a study that adopted LCA identified 0–1 ACE class as the most prevalent group occupying more than three quarters of the sample (Lanier et al., 2018). The interpretation of the results may be hindered by inaccurate representation of the classes because the members of the classes (e.g., No ACEs) are not exactly individuals with none of ACEs, but scattered from 'have little' to 'no risk'. These results indicate a possibility of existing different typologies when devoted to those who experienced at least one ACE. Therefore, prior work still left much room for investigation about at- risk population.

Present study

Despite the common challenges found in both ACEs and mental health concerns among adolescents, the association of ACEs on adolescents' mental health concerns has not yet been fully investigated. The purpose of this study is to identify latent groups of ACEs in adolescents who experienced at least one ACE and to examine the association between class membership and the prevalence of mental health concerns

(i.e., depression, anxiety problem). In this study, two mental health concerns have been assessed via reports from adolescents' parents or caregivers, rather than clinicians' diagnosis. Therefore, we used the term anxiety problems in this study, rather than anxiety disorder. Understanding adolescents' mental health concerns may be a promising way to design interventions, and ultimately minimize adverse effects in later life. As such, given the heterogeneity within the population with ACEs, this study employed latent class analysis (LCA) to find un- observed subpopulation structures (i.e., latent classes) based on observed categorical data (i.e., reported data). We expected that this study would be able to help practitioners understand how an array of and comorbidity in ACEs are associated with the degree of depression and anxiety problems. By looking at various forms of adversity rather cumulative scores of ACEs alone, we may identify important interactions and their relevance to mental health concerns. We further examined severities of depression and anxiety problems across class memberships. Our two research questions were as follows:

(1)   What is the nature of class membership of ACEs?

(2)   What is the association between class membership of ACEs and depression and anxiety problems?

Method

Survey data

The current study used 2016 National Survey of Children's Health (NSCH), a random-digit, large cross-sectional, nationally representative survey designed and sponsored by the U.S Maternal and Child Health Bureau in partnership with the National Center for Health Statistics, Child and Adolescent Health Measurement Initiative, and a National Technical Expert Panel. The respondents of the 2016 NSCH data were parents or caregivers of children and adolescents who are 0–17 years old, across the 50 states and the District of Columbia. Questionnaires assessed children and adolescents' demographics, physical/mental/developmental problems, well-being, parental health, school-related fac- tors, and neighborhood-related factors. The 2016 data were also weighted to represent the U.S. population rendering demographic composition of non-institutionalized children in each state. Among a total of 50,212

respondents, sample for 10–17 years of age was 26,094. Then, 14,657 participants were excluded from all analyses due to either missing data in terms of ACEs questionnaires or reporting no any other experiences of adversity during childhood. Consequently, a total of 11,437 respondents were analysed to determine profiles for adolescents' ACEs. Among 11,437 respondents, all did not report their demographics such as family structure, parents' highest education level, and mental health problems (i.e., depression, anxiety problem). Nevertheless, given our primary focus is to find (a) latent class profiles for ACEs and (b) its association with mental health problems, we determined 11,437 as a sample in this study.

Measures
Adverse childhood experiences (ACEs)

Since the 2011/12 NSCH, questionnaires on ACEs have been added to investigate the risk factors affecting children's development. The 2016 NSCH survey adjusted and reworded nine questions on ACEs for clear understanding. Respondents who are either parents or caregivers were asked to report the nine ACEs questions for their children or adolescents. The items on the questionnaire are as follows: (a) income hardship: hard to get by on family's income-hard to cover basics like food or housing, (b) divorce: parent or guardian divorced or separated, (c) death: parent or guardian died, (d) jail: parent or guardian served time in jail, (e) domestic violence: saw or heard parent or adults slap, hit, kick, punch one another in the home, (f) neighborhood violence: victim/witness of neighborhood violence, (g) mental health: lived with anyone who was mentally ill, suicidal, or severely depressed, (h) drug use: lived with anyone who had a problem with alcohol or drug, and (i) discrimination: treated or judged unfairly because of his/her race or ethnic group.

All the items, except for income hardship, were dichotomous questions (i.e., Yes/No experience). Income hardship, which originally had four response options (i.e., never, rarely, somewhat often, and very often), was transformed into a dichotomous question; either 'somewhat often' or 'very often' was recoded as Yes, and either 'rarely' or 'never' was recoded as No. See Table 2 for ACEs questionnaires (NSCH, 2016).

Depression and anxiety problem

The NSCH survey contains multiple measures assessing mental health concerns (e.g., depression, anxiety problem). This study investigated the relationships between ACEs and pre-existing and current conditions of depression and anxiety problem, respectively. Original NSCH survey included three questionnaires in association with children and adolescents' pre-existing conditions and current conditions of depression and anxiety problem. More specifically, respondents were asked to report: (a) their children's or adolescents' pre-existing conditions of depression and anxiety problem in a binary fashion (i.e., Yes or No), (b) their children's or adolescents' current conditions of depression and anxiety problem in a binary fashion (i.e., Yes or No), (c) if respondents selected Yes in (b), respondents were further asked to rate the severity of current conditions as either mild, moderate, or severe.

In this study, adolescents' pre-existing conditions of depression and anxiety problem were analysed in a binary fashion like original NSCH questionnaires. Also, we analysed adolescents' current conditions and its severity in one item with four options. The four options included: (a) does not currently have condition (i.e., none), (b) current condition, rated mild (i.e., mild), (c) current condition, rated moderate (i.e., moderate), and (d) current condition, rated severe (i.e., severe).

Sociodemographic

In this study, sociodemographic variables included adolescents' age, gender, race/ethnicity, family structure, household income, and highest education level of primary caregivers (i.e., parents or guardians). In particular, race/ethnicity categories were collapsed into (a) White, (b) Black of African American, (c) Asian, (d) Native Hawaiian and Other Pacific Islander, (e) Some other races, and (f) two or more races. For family structure, respondents were asked to identify the relationships of parents (e.g., biological/adoptive parents, step-parents) in the household and their marital status. Four options were described: (a) two parents, currently married, (b) two parents, not currently married, (c) single mother (currently married/living apart, formerly married or never married), and (d) other family type, no parent reported. Moreover, household income refers to the income level of adolescents' household with four levels: (a) 0–99%

federal poverty level (FPL), (b) 100–199% FPL, (c) 200–399% FPL, and (d) 400% FPL or greater.

Further, the respondents were asked to report highest education of primary caregiver in their household: (a) less than high school, (b) high school or GED, (c) some college or technical school, and (d) college degree or higher. Sociodemographic variables were considered when running a series of ordinal regression to examine severities of current mental health concerns (i.e., depression, anxiety problem) across ACEs profiles identified.

Statistical analyses

The statistical analyses proceeded in multiple steps. First, for the research question 1, we identified the number of classes to represent the heterogeneous combinations of ACEs. LCA was employed for adolescents who was considered at least one of adverse childhood experiences. Through LCA, each subject was assigned a class membership, by using posterior probabilities of class membership. Posterior probabilities in LCA are characterized by the likelihood that each participants or respondents were placed into a particular class. The ACEs data were analysed within a series of models with increasing number of la- tent classes from 3-class to 6-class models using Mplus 8.2 (Muthén & Muthén, 2017). In order to select a model with the best fit, bootstrap likelihood ratio test (BLRT) would have been an ideal way to assess the improvement in model fit (Nylund, Asparouhov, & Muthén, 2007). Given that BLRT is not applicable to data with weighted values, alter- natively, *p*-values of Lo-Mendell-Rubin likelihood ratio test (LMR, Lo, Mendell, & Rubin, 2011) and Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMR, Vuong, 1989) were employed in this study. These two indicators are promising criteria as they compare neighboring class models (i.e., comparing k-1 and the k class models) and test statistical significance based on *p* values, demonstrating if a model fit is statistically improved by adding one more class. Further, information criteria such as Akaike's information criterion (AIC), Bayesian information criterion (BIC), sample-size adjusted BIC (SSBIC), and the entropy value were also used to find the best model fit.

For the second research question, two steps were proceeded to analyse the

associations between class memberships and both pre-existing and current conditions of depression and anxiety problem, respectively. Chi-square tests were performed first to examine the association between class memberships and pre-existing condition of mental health concerns, including depression and anxiety problem. Then, a series of ordinal regression were conducted to examine the associations between class memberships and the extent of severity of current conditions in depression and anxiety problems, after controlling for sociodemographic variables.

Table 1

Descriptive statistics (10–17 years of age).

Variables	Unweighted n[a]	Weighted %
Age	13.96 (2.25)	
Gender (male) (n = 11,437)	5,800	51.60
Race/Ethnicity (n = 11,437)		
White	8,666	63.68
Black or African American	966	18.57
American Indian or Alaska Native	123	1.09
Asian	392	2.59
Native Hawaiian and Other Pacific Islander	52	0.41
Some other race	325	6.70
Two or more races	913	6.96
Family Structure (n = 11,394[a])		
Two parents, currently married	5,679	45.03
Two parents, not currently married	1,128	10.61
Single mother (currently married living apart, formerly married, or never married)	3,034	29.96
Other family type, no parent reported	1,553	14.40
House Income[b] (n = 11,437)		
0–99% FPL[c]	1,608	28.37
100–199% FPL	2,391	25.46
200–399% FPL	3,865	25.88
400% FPL or greater	3,573	20.29
Primary Caregivers' Education Level (n = 11,298[a])		
Less than high school	369	11.60
High school/GED	2,043	25.70
Some college/technical school	3,465	27.91
College degree or higher	5,421	34.78

Note: [a]Total *n* for each variable may differ due to missing values.

[b]Household income represents the relative poverty ranking on the basis of household size and income.

[c]FPL denotes Federal Poverty Level.

Results

Sample characteristics

A total of 11,437 adolescents who experienced at least one ACE were analysed in this study. 51.60% of adolescents were male ($n = 5800$; female: $n = 5637$). The majority of the sample was White (63.68%), followed by African American (18.57%), biracial status (6.96%), and some other races (6.70%), and Asian (2.59%). See Table 1 for descriptive statistics in association with sociodemographic variables.

Research question 1: Latent class analysis for ACEs

For our first research question, we were interested in the nature of adolescents' adverse childhood experience. Adolescents' ACE clusters were determined by jointly considering a variety of adverse childhood experience. The most prevalent ACEs reported was divorce (60.68%) and income hardship followed secondly (48.52%). While the pre- valence of three ACEs (i.e., jail, mental health, and drug use) constituted about 18–22%, the prevalence of parents' death and dis- crimination were relatively low as about 9% (see Table 2).

To find the different combinations of ACEs (e.g., household income, physical violence, emotional violence), we ran a series of latent class analysis from 3-class through 6-class for the adolescents who had at least one ACEs. To find the best model fit, we considered information criteria (e.g., AIC, BIC), entropy, *p*-values of VLRM and LMR, and sample size in each class membership. Specifically, as the number of classes increased, BIC as a primary indicator showed a decrease. A greater entropy value approximating to 1 indicates a more precise indicator of the best model (Celeux & Soromenho, 1996). Although the five-class membership had the highest entropy (entropy value = 0.87), no significant results were found in association with both VLRM and LMR. Therefore, we ended up with displaying the four class member- ships by considering significant p-values of VLMR and LMR as well as low BIC and high Entropy. See Table 3 for latent class analysis fit statistics. Fig. 1 depicts the results of latent class analysis.

Consequently, we ended up our final model reflecting the four class

memberships. Class 1 included 17.27% of adolescents (*n* = 1975). These had adverse experience in a variety of adverse childhood experience including parents' divorce, witnessing domestic or neighbor- hood violence, and witnessing drug use, with high-likelihood. We termed this class *Multiple High-Risk* class because it included adolescents who were highly likely to experience a variety of simultaneous adverse childhood experience. Class 2 (44.59%, *n* = 5100) included adolescents who had confronted parents' divorce or death. We described Class 2 as *Broken Family* class because those who have been specifically raised under incomplete family structures (e.g., single mother or single father). In Class 3 (19.93%, *n* = 2279) were adolescents who were heavily problematic in their family financial status. We termed these adolescents *Income Hardship* class as they have been struggling with household income, rather than larger effect of physical or mental violence. Finally, Class 4 included 18.21% of adolescents (*n* = 2082) who had adverse childhood experience, but low risk. We described this class as *Multiple Low-Risk* class because these adolescents were relatively low likelihood to have ever adverse experience, as compared to the Class 1 (i.e., *Multiple High-Risk* class).

Table 2

Descriptive statistics of adverse childhood experience, weighted.

ACE (Adverse Childhood Experience) (n = 11,437)	Unweighted n	Weighted %
Income hardship (Yes): somewhat/very often hard to get by on family's income-hard to cover basics like food or housing	4,762	48.52
Divorce (Yes): parent or guardian divorced or separated	6,841	60.68
Death (Yes): parent or guardian died	1,012	9.39
Jail (Yes): parent or guardian served time in jail	1,733	18.62
Domestic violence (Yes): saw or heard parent or adults slap, hit, kick, punch one another in the home	1,401	13.23
Neighborhood violence (Yes): victim/witness of neighborhood violence	1,118	10.58
Mental health (Yes): lived with anyone who was mentally ill, suicidal, or severely depressed	2,542	18.18
Drug use (Yes): lived with anyone who had a problem with alcohol or drug	2,805	21.96
Discrimination (Yes): treated or judged unfairly because of his/her race or ethnic group	979	9.87

Research question 2. Associations between ACEs and depression/ anxiety problem

Descriptive statistics

Table 4 included descriptive statistics for mental health concerns reported. In particular, 9.50% of the adolescents were identified as having depressive symptom with different levels of severity, which were classified as mild, moderate, and severe. Likewise, a similar pattern was found in association with anxiety problem. 16.11% of

the adolescents were reported as currently having anxiety symptoms with varying levels of severity.

Table 3

Latent class analysis fit statistics, weighted.

# of classes	Information criteria			Log likelihood	Entropy	p-value	
	AIC	BIC	SSABIC			VLMR	LMR
3	90440.27	90653.27	90561.11	−45191.14	0.72	0.04	0.04
4	89101.07	89387.51	89263.57	−44511.53	0.79	0.02	0.02
5	88656.82	89016.70	88860.99	−44279.41	0.87	0.27	0.28
6	88462.11	88895.44	88707.95	−44172.06	0.79	0.75	0.75

Table 4

Descriptive statistics for mental health concerns, weighted.

Mental Health Concerns	Unweighted n[a]	Weighted %
Depression		
Pre-existing condition (n = 11,401[a])		
Yes	1,422	12.47
No	9,979	87.53
Current condition (n = 11,346[a])		
None	10,268	90.50
Mild	492	4.34
Moderate	485	4.27
Severe	101	0.89
Anxiety		
Pre-existing condition (n = 11,388[a])		
Yes	2,153	81.09
No	9,235	18.91
Current condition (n = 11,312[a])		
None	9,490	83.89
Mild	806	7.13
Moderate	839	7.42
Severe	177	1.56

Note: [a]Total n for each variable may differ due to missing values.

Pre-existing conditions

We ran two chi-squared tests to examine the association between ACE class membership and their pre-existing condition of depression and anxiety problem. Chi-squared tests determined that the proportion of pre-existing condition of mental health concerns varied significantly across the four class memberships. Significant results were found in both depression [$x^2(3) = 317584.98$, $p < 0.001$]. For depression, as comparing the ratio within each class, the most prominence have been found in the Multiple High-Risk class (20.84%), followed by the Multiple Low-Risk class (9.34%), the

Broken Family class (7.77%), and the Income Hardship class (6.87%), in sequence. Moreover, in terms of prevalence for anxiety problem, the same sequence with depressive symptoms was identified; the Multiple High-Risk class (26.23%), followed by the Multiple Low-Risk class (15.69%), the Broken Family class (12.83%), and the Income Hardship (11.91%), sequentially. See Table 5 for descriptive statistics results.

4.3.3. Current conditions

In addition to adolescents' pre-existing conditions of mental health concerns, we investigated adolescents' current conditions of depression and anxiety problem. Overall, while the highest proportions of current mental health concerns including the three levels (i.e., mild, moderate, and severe) were found in the Multiple High-Risk class (from 1.69% to 6.75%), the lowest were found in the Income Hardship class (from 0.41% to 2.21%). Similar aspects were identified in association with the anxiety problem as well. See Table 6 for summary.
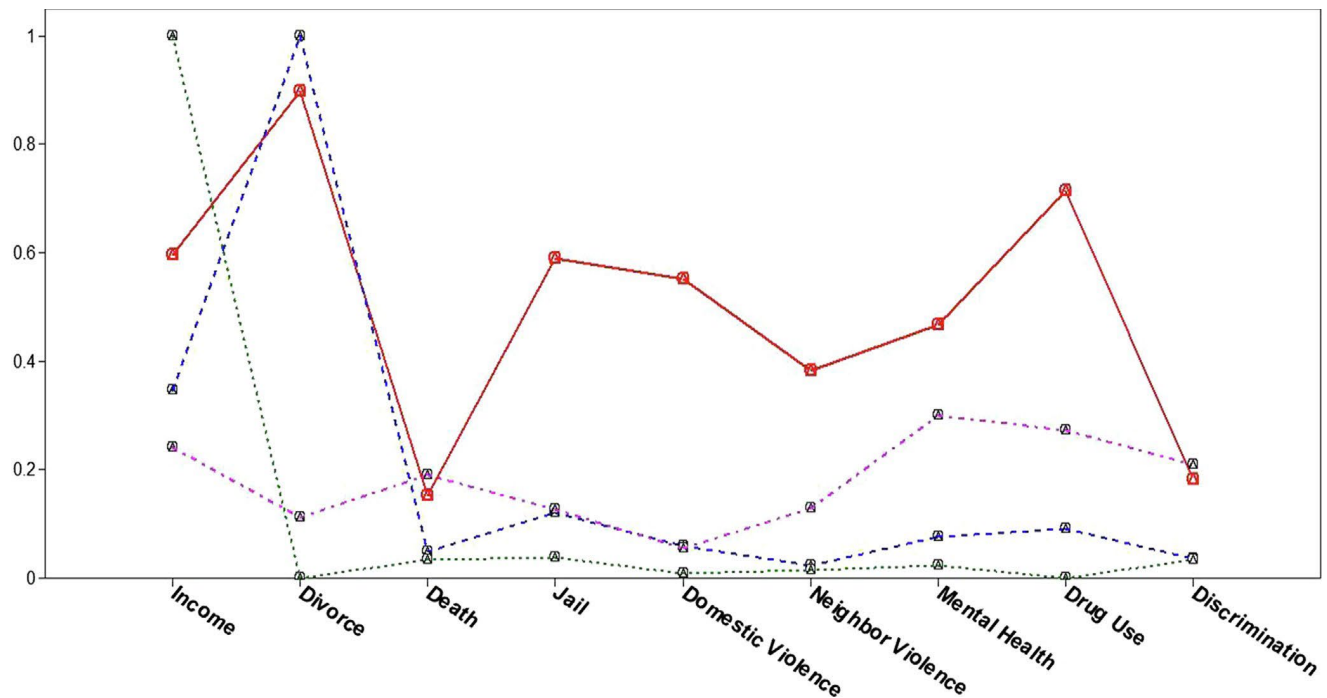
Fig. 1. Response patterns identified in the latent class analysis (posterior probabilities of class membership) [Solid line in red: Multiple High-Risk class; Dashed line in blue: Broken Family class; Dotted line in green: Income Hardship class; Dash-dotted line in Magenta: Multiple Low-Risk class]

Table 6

Current conditions of depression and anxiety problem, weighted.

Class membership	Mental health	None	Mild	Moderate	Severe
1. Multiple High-Risk	Depression	83.64%	6.75%	7.92%	1.69%
ACEs (17.27%)	Anxiety	77.09%	10.08%	9.86%	2.97%
2. Broken Family	Depression	94.08%	3.28%	2.15%	0.49%
(44.59%)	Anxiety	89.61%	4.94%	4.91%	0.54%
3. Income Hardship	Depression	95.52%	1.95%	2.12%	0.41%
(19.93%)	Anxiety	90.06%	4.48%	4.74%	0.72%
4. Multiple Low-Risk	Depression	92.42%	2.78%	3.16%	1.63%
ACEs (18.21%)	Anxiety	85.76%	6.20%	6.61%	1.43%

Moreover, two ordered logistic regressions were run to examine the extent to severities of mental health concerns are associated with their profiles of adverse childhood experiences. For these ordered logistic regressions, adolescents' severities of current mental health concerns for depression and anxiety problem were entered as dependent variables. A set of independent variables included adolescents' socio-demographic variable such as age, sex, race/ethnicity, family structure, poverty level, and highest education level of primary care and four ACE classes.

First, for current severities of depression, the overall model was found to be significant, $\chi^2(12259) = 30690018.70$, $p < 0.001$ with pseudo R^2 measures varying from 0.04, according to Cox and Snell's R^2 to 0.09, according to Nagelkerke's R^2. In particular, the odds of the Multiple High-Risk ACEs class having severer depression problem was 2.20 (95% CI, 2.19 to 2.21) times that of the Multiple Low-Risk ACEs class, a statistically significant effect, Wald $\chi^2(1) = 68227.11$, $p < 0.001$. Likewise, the odds of the Income Hardship class having severer depressive symptom was 0.76 (95% CI, 0.75 to 0.76) times that of the Multiple Low-Risk ACEs class, a statistically significant effect, Wald $\chi^2(1) = 8930.44$, $p < 0.001$. Finally, the odds of Income Hardship class having severer depressive symptoms was 0.53 (95% CI, 0.53 to 0.54) times that of Multiple Low-Risk ACEs class, also a statistically significant effect, Wald $\chi^2(1) = 31161.43$, $p < 0.001$. Table 7 summarized parameter estimates to predict current conditions of de- pression.

Table 7

Parameter estimates for current conditions of depression.

Variables	Estimate	SE	Wald	EXP(B)	Lower bound	Upper bound
Age	0.19	0	174689.60	1.21***	1.21	1.21
Sex (Reference group = Female)						
Male	−0.34	0.00	30936.57	0.71***	0.71	0.71
Race (Reference group = Two or more races)						
White	−0.12	0.00	1051.22	0.89***	0.88	0.90
African American	−0.26	0.00	4053.21	0.77***	0.76	0.77
American Indian or Alaska Native	−0.11	0.01	153.47	0.90***	0.88	0.91
Asian	−1.07	0.01	10508.44	0.34***	0.34	0.35
Native Hawaiian and Other Pacific Islander	−0.73	0.02	937.28	0.48***	0.46	0.51
Some other race	−1.16	0.01	32091.59	0.31***	0.31	0.32
Family structure (Reference group = Other family type, no parent reported)						
Two parents, currently married	0.49	0.00	21433.62	1.63***	1.62	1.64
Two parents, not currently married	−0.04	0.00	96.99	0.96***	0.95	0.97
Single mother	0.44	0.00	18587.22	1.55***	1.54	1.56
House Income (Reference group = 400% FPL or greater)						
0–99% FPL	0.35	0.00	11728.57	1.43***	1.42	1.43
100–199% FPL	0.10	0.00	892.765	1.10***	1.10	1.11
200–399% FPL	−0.01	0.00	9.78	0.99**	0.98	1.00
Primary Caregivers' Education Level (Reference group = College degree or higher)						
Less than high school	0.57	0.00	26984.66	1.76***	1.75	1.77
High school/GED	0.02	0.00	31.67	1.02***	1.01	1.02
Some college/ technical school	0.15	0.00	3014.28	1.16***	1.15	1.16
Class (Reference group = Multiple Low-Risk ACEs class)						
Multiple High-Risk ACEs	0.79	0.00	68227.11	2.20***	2.19	2.21
Broken Family	−0.28	0.00	8930.44	0.76***	0.75	0.76
Income Hardship	−0.63	0.00	31161.43	0.53***	0.53	0.54

** $p < 0.01$.
*** $p < 0.001$.

Second, for current severities of anxiety problem, the overall model was found to be significant, $\chi^2(12274) = 28613053.94$, $p < 0.001$. with pseudo R^2 measures varying from 0.04, according to Cox and Snell's R^2 to 0.07, according to Nagelkerke's R^2. Specifically, the odds of the Multiple High-Risk ACEs class having severer depression problem was 1.84 (95% CI, 1.83 to 1.85) times that of Multiple Low-Risk ACEs class, a statistically significant effect, Wald $\chi^2(1) = 61914.63$, $p < 0.001$. Likewise, the odds of the Income Hardship class having severer depressive

symptom was 0.74 (95% CI, 0.74 to 0.74) times that of the Multiple Low-Risk ACEs class, a statistically significant effect, Wald $\chi^2(1) = 17903.36$, $p < 0.001$. Finally, the odds of the Income Hardship class having severer depressive symptoms was 0.65 (95% CI, 0.65 to 0.65) times that of the Multiple Low-Risk ACEs class, also a statistically significant effect, Wald $\chi^2(1) = 27191.62$, $p < 0.001$. See Table 8 for parameter estimate summary.

Table 8

Parameter estimates for current conditions of anxiety problem.

Variables	Estimate	SE	Wald	EXP(B)	Lower bound	Upper bound
Age	0.04	0.00	17390.29	1.05***	1.05	1.05
Sex (Reference group = Female)						
Male	−0.17	0.00	13073.45	0.84***	0.84	0.84
Race (Reference group = Two or more races)						
White	−0.51	0.00	41147.45	0.60***	0.60	0.61
African American	−1.33	0.00	159258.71	0.26***	0.26	0.27
American Indian or Alaska Native	−1.05	0.01	14416.11	0.35***	0.34	0.36
Asian	−1.47	0.01	39348.53	0.23***	0.23	0.23
Native Hawaiian and Other Pacific Islander	1.41	0.01	28092.59	4.09***	4.03	4.16
Some other race	−0.63	0.00	25986.60	0.53***	0.53	0.54
Family structure (Reference group = Other family type, no parent reported)						
Two parents, currently married	0.54	0.00	38420.33	1.71***	1.70	1.72
Two parents, not currently married	0.36	0.00	11044.51	1.43***	1.42	1.44
Single mother	0.54	0.00	40335.79	1.72***	1.71	1.73
House Income (Reference group = 400% FPL or greater)						
0–99% FPL	0.09	0.00	1432.48	1.10***	1.09	1.10
100–199% FPL	−0.06	0.00	666.71	0.94***	0.94	0.94
200–399% FPL	−0.24	0.00	11130.31	0.79***	0.78	0.79
Primary Caregivers' Education Level (Reference group = College degree or higher)						
Less than high school	0.04	0.00	209.81	1.04***	1.04	1.05
High school/GED	−0.42	0.00	32010.52	0.66***	0.66	0.66
Some college/ technical school	−0.07	0.00	1171.02	0.93***	0.93	0.94
Class (Reference group = Multiple Low-Risk ACEs class)						
Multiple High-Risk ACEs	0.61	0.00	61914.63	1.84***	1.83	1.85
Broken Family	−0.30	0.00	17903.36	0.74***	0.74	0.74
Income Hardship	−0.43	0.00	27191.62	0.65***	0.65	0.65

*** $p < 0.001$.

Discussion

The goal of this study was to examine the heterogeneity within the ACEs

population and its association with depression and anxiety problem. In particular, we conducted latent class analysis to identify different combinations of adverse childhood experiences, with the nationally representative sample from NSCH 2016 data. Consequently, we identified the 4-class membership to represent the combinations of ACEs. Second, we found significant differences in the levels of depression and anxiety problem, across four class memberships of ACEs. The association between combinations of ACEs and mental health concerns were discussed in turn.

RQ1. Latent class analysis for ACEs

For the first research question, we examined interactions of ACEs among adolescents with at least one ACEs, by adopting latent class analysis. We identified four class memberships to represent the different combinations of adolescents' ACEs. Specifically, the *Multiple High-Risk* class has experienced a high ratio of multiple ACEs, con- currently. *The Broken Family class* is characterized as adolescents primarily experiencing parents' divorce, along with some adolescents having income hardship. *The Income Hardship class* has primarily experienced financial issues to maintain their household. Lastly, the *Multiple Low-Risk class* is likely to experience ACEs concurrently, but not highly as the *Multiple High-Risk* class. These findings can be interpreted in a number of ways.

First, building on previous studies to examine cumulative effect of ACEs (Balistreri, 2015; Lanier et al., 2018), this study found two distinct patterns of multiple ACEs. Indeed, unlike prior studies that adolescents with more ACEs were more likely to experience higher level of de- pression and anxiety problem (Karatekin, 2017), this study suggested the Multiple Risk class to be collapsed into (a) High-Risk and (b) Low-Risk. That is, these two classes had a variety of ACEs at the same time, however, the likelihood of experiencing ACEs was quite a bit different. More specifically, the *Multiple High-Risk* class has high risks across ACEs, showing 4.69 ACEs on average. In the *Multiple Low-Risk* class, none of the ACEs were endorsed by more than 50% of the group. Nevertheless, mental health and drug use problems were relatively conspicuous experiences for adolescents in the *Multiple Low-Risk* class. This distinct pattern of ACEs may be a basis to design and develop corresponding interventions to

adolescents.

Further, the remaining class membership -which are *Income Hardship* class or the *Broken Family* class – presented one or two salient 2017), this study only targeted people who have experienced at least one or more ACEs. This approach, delimiting the sample who have experienced one or more ACEs, may provide a more penetrating ex- amination on how the at-risk population can be composed of. For example, in one study using LCA for adolescents with adverse childhood experience, Lanier et al. (2018) collapsed sample into eight classes of ACEs. Among eight class membership, the most prevalent one is adolescents with 0–1 ACEs (75.8%). In their study, the adolescents with 0–1 ACEs were more likely to have experience in association with either poverty or parents' divorce. These family dysfunction item (e.g., poverty, parents' divorce) was reflected in 0-1 ACEs of class, we identified the family dysfunction as a salient thing – that is, Income *Hardship class* (19.93%) and *Broken Family* class (44.59%).

Consequently, beyond counting the number of ACEs adolescents have experienced, LCA approach captured distinct features in association with each class membership. This finding helps us that LCA pictures how specific combination of ACEs are made among ACEs populations. Indeed, this result may not be captured though adopting cumulative effects of ACEs, since the use of cumulative effects of ACEs is limited to capture whole information about heterogeneity of or other patterns of ACEs (Barboza, 2018).

RQ2. Associations between ACEs and depression/anxiety problem

The second research question examined the associations between mental health problems and different class memberships reflecting a variety of combinations of ACEs. Specifically, we collapsed pre-existing and current conditions of depression and anxiety problems. Building upon prior work to examine the association between ACEs and various mental health concerns (Bright, Knapp, Hinojosa, Alford, & Bonner, 2016; Bright & Thompson, 2018; Lanier et al., 2018), this study adopted a new methodological approach. Rather than just employing individual ACE scores or cumulative effect of ACEs scores on mental health problems, we looked at the effects of combinations of

ACEs on mental health concerns. We expected that a variety of combinations of ACEs may be likely to have different aspects of the level of depression and anxiety level. Overall, the results of this study confirmed that different combinations of ACEs can have distinct patterns of depression and anxiety problem. A number of conclusions were drawn from the findings.

First, the highest level of depression and anxiety was found in the *Multiple High-Risk* class as compared to the other three classes. That is, adolescents with multiple high-risk adverse experiences were more likely to have higher levels of depression and anxiety problems. Beyond prior work examining that the cumulative ACEs score had a strong relationship to mental health concerns (Schilling, Aseltine, & Gore, 2007), this study found that a variety of combinations of ACEs with high-likelihood may also stimulate the symptoms of depression and anxiety problems, as compared to adolescents with multiple low-risk adverse experiences.

Second, interesting finding emerging from this study is the levels of depression and anxiety problem in the *Multiple Low-Risk* class were found to be higher than those of both the *Broken Family* and the *Income Hardship* classes. Although the average number of ACEs scores of three class memberships were found to be similar level (i.e., Broken Family = 1.76, Income Hardship = 1.16, and Multiple Low- Risk = 1.56), the *Multiple Low-Risk* class presented higher scores in depression and anxiety than the *Broken Family* and the *Income Hardship* classes. This finding indicates that mental health risks can be contingent on combinations of ACEs, in addition to independent or cumulative effects of ACEs. Adolescents in the *Multiple Low-Risk* class have been directly exposed to either mental health problems or risky health behavior in their household. By contrast, the *Broken Family* class and the *Income Hardship* class seems to have an issue arising from their social status (e.g., economic status or family structure). It seems that a variety of combinations of adverse childhood experiences due to different at- tributes may have concurrently, but different functioning on their de-pression and anxiety problem level.

Third, in addition to the direct experiences of abuse or adversity, insufficient finance in a household may be a critical factor to deteriorate adolescents' mental health concerns. Indeed, as previous studies, children who have grown up in a divorced family

(with financial issues) was found to be vulnerable to mental health difficulties with develop- mental perspective (Chase-Lansdale, Cherlin, & Kiernan, 1995). More specifically, children or adolescents from a single parent household may have fewer opportunities to have family-related activities (e.g., parents read books to their children or eat outside) due to a limited budget. The limited opportunities may prevent them from building positive child- parent relationships, thereby furthering its direct or indirect influence on poorer social competence with non-family members in school (Allen, Hauser, Bell, & O'Connor, 1994), which can lead to the emergence of developmental disorders and mental health issues (Ratcliffe, Wong, Dossetor, & Hayes, 2015).

Implications

Our findings suggest that service providers consider the combinations of ACEs and depression and anxiety together when providing care and service for youth. When adolescents are found to have multiple ACEs, they are more likely to experience severe depression and anxiety problem. On the other hand, if the adolescents report either depressive symptoms or anxiety problems, practitioners may consider asking if the adolescents experienced ACEs, especially multiple ACEs or mental health or drug use problems in their households.

Findings from the current study have implications for prevention and interventions across all four classes. Prevention from the negative impacts of ACEs on depression and anxiety can be considered in social and ecological contexts. Existing studies highlight the importance of social and emotional support as protective factors from the negative impacts of ACEs on depressive symptoms (Brinker & Cheruvu, 2017; Roh et al., 2015). From an ecological perspective, collaboration in school, family, and community is imperative to build resilience among adolescents and construct ecological environments as resilience plays a mitigating role from the impacts of ACEs (Bethell et al., 2014). For example, building resilience within the family and community can mitigate the impacts of ACEs among adolescents by promoting positive family processes (Oshri et al., 2015) as well as developing collective goals and shared work plans among community partners (Ellis & Dietz, 2017).

Practitioners should consider helping adolescents achieve adversarial growth,

with the considerations of adversity-activated development (AAD) and posttraumatic growth (PTG), after experiencing childhood adversities (Linley & Joseph, 2004; Papadopoulos, 2007). Furthermore, expanding the utilization of Trauma-Informed Care (TIC) and trauma-informed practices in communities can address various childhood adversities and complex traumas, which affect adolescents' adaptive development (Bartlett et al., 2018; Oral et al., 2016).

Limitations

Despite these contributions to the literature and clinical settings, several limitations must be acknowledged. First, the data from the cross-sectional survey did not capture changes in adolescents' exposure to ACEs and their mental health concerns over time. Without con- sideration of temporal changes for ACEs, the precise causality between ACEs and other variables (e.g., physical health, mental health, school readiness) cannot be established. Longitudinal studies for ACEs are necessary to fully understand the potential consequences of ACEs. Second, the variance of ACEs among respondents remains open to be questioned. Future work should consider polytomous items for ACEs, since the dichotomous ratings used in this study may not be sufficient to examine the severity or duration of ACEs.

Third, the use of self-report measures reported by the parents or guardians of the children and adolescents may be involved with response error or bias. It is possible that parents underreported their socially undesirable events, such as domestic violence or alcohol/drug abuse. Further, each mental health concern has been assessed through the perceptions of parents or caregivers only, which does not reflect clinical diagnoses and adolescents' perceptions. This may be resolved by asking whether the adolescents had ever been professionally diagnosed and by utilizing multiple respondents. The limitations of the questionnaire may indicate that responses from the survey may contain some errors, considering the respondents' possible responsiveness or unresponsiveness to sensitive questions. Lastly, the NSCH data did not include some of the conventional ACE items, such as emotional and physical abuse/neglect. It is recommended to cautiously interpret the results of the study considering individual items of ACEs in this data.

Conclusion

The current study examined a greater number of ACEs in childhood associating with mental health concerns. The findings of this study, using a person-centered analysis (i.e., LCA in this study), provide a better understanding of the associations between heterogeneous combinations of ACEs and depression and anxiety problem, respectively. This study has the potential to inform practitioners of the selection and adaptation of clinical interventions appropriate for individuals who have suffered from adverse childhood experiences. Moreover, this study highlights the importance of preventive approaches to addressing de- pression and anxiety problem of adolescents with ACEs, by suggesting the necessities of interventions in association with the mental health symptoms. Taken together, these findings point to the need to further consider inter-relations of adverse childhood experiences, socio- demographic characteristics, and a variety of mental health difficulties.

Credit authorship contribution statement

Hye Yeon Lee: Methodology, Software, Formal analysis, Data curation, Writing - original draft, Writing - review & editing, Visualization, Validation. Isak Kim: Conceptualization, Methodology, Writing - original draft, Writing - review & editing, Supervision, Project administration. Sojeong Nam: Writing - original draft, Writing - review & editing. Jeongwoon Jeong: Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors have no conflict of interest.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.childyouth.2020.104850.

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