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FULL-LENGTH REPORT

Relationship between adverse childhood experiences and problematic internet use among young adults: The role of the feeling of loneliness trajectory

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ABSTRACT

Backgrounds and aims: Given problematic Internet usage's (PIU) negative impact on individual health, this study evaluates how adverse childhood experiences (ACEs) affect young adults' PIU and the possible underlying mechanism of the "feeling of loneliness" (FOL) trajectory. *Methods:* Analyzing a retrospective cohort sample from the Taiwan Youth Project, 2,393 adolescents were interviewed from the average ages of 14–28. We constructed ACE in 2000 using six categories (e.g., abuse and low family socioeconomic status) and 5-item PIU in 2017 from Chen's Internet Addiction Scale. FOL trajectories measured eight times, at average ages 14, 16, 17, 18, 20, 22, 25, 28 years-old. *Results:* Overall, 12.65% of the participants did not have ACEs, and 12.78% exhibited PIU. FOL trajectory analyses yielded three groups: "constant low" (reference group: 53.25%); "moderate decline" (36.81%); and "increasing" (9.94%). Regression models showed a dose–response association between ACE and young adults' PIU (adjusted odds ratio = 1.12; 95% confidence interval [CI] = 1.02–1.23) and the two risky loneliness groups (moderate decline: relative risk ratio [RRR] = 1.42, 95% CI = 1.32–1.54; increasing: RRR = 1.52, 95% CI = 1.37–1.71). Structural equation modeling further found that ACEs increase young adults' risk of being in the increasing group, and consequently, the risk of PIU. *Discussion and conclusions:* We demonstrated that ACE may be associated with 1) adults' PIU, 2) FOL from adolescence to emerging adulthood, and 3) young adults' PIU through its association with FOL trajectories.

KEYWORDS

adverse childhood experiences (ACE), problematic internet use (PIU), loneliness trajectories, young adults, longitudinal study

INTRODUCTION

Excessive or inappropriate Internet use poses serious concerns for individual health and well-being. Although the literature uses several terms interchangeably (de Vries, Nakamae, Fukui, Denys, & Narumoto, 2018), such as excessive Internet use (Yang, Choe, Baity, Lee, & Cho, 2005), Internet addiction (Spada, 2014), or problematic Internet use (PIU) (Caplan, 2002), has gained popularity and acceptance (Laconi et al., 2018). In this study, PIU is characterized by impulsive–compulsive Internet use, withdrawal symptoms when not using the Internet, comfort-seeking attachment with the Internet, and negative effects on functioning (e.g., academic/occupational, or mental) (Yates, Gregor, & Haviland, 2012).

Understanding the developmental factors contributing to PIU among young people, in addition to adolescents (Fumero, Marrero, Voltes, & Penate, 2018), is important for

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addressing its negative impacts. Studies have shown that PIU (including Internet addiction) is harmful to physical health (Chern & Huang, 2018; Kim, Wineinger, & Steinhubl, 2016) and compromises mental health (Kitazawa et al., 2018; Leménager et al., 2018; Pan & Yeh, 2018). Consequently, Gámez-Guadix, Calvete, Orue, and Hayas (2015) called PIU a public-health issue.

Adverse childhood experience (ACE) is a possible early risk factor of PIU from both theoretical and empirical perspectives. According to the Interaction-Person-Cognition Executive (I-PACE) theory (Brand, Young, Laier, Wölfling, & Potenza, 2016), early adverse experiences are crucial to problematic technology-related behaviors (i.e., PIU). Taking the stress paradigm (Lynch & Smith, 2005; McEwen, 1998) and coping perspective (Caplan & High, 2010; Kardefelt-Winther, 2014), individuals often employ various stimuli, including Internet, to compensate for or escape from life stress. Empirically, research has found a correlation between ACE and PIU (Arslan, 2017; Yates et al., 2012) or similar behaviors, such as problematic mobile (Li, Zhang, Chu, & Li, 2020). Most of them have focused on adolescents rather than young adults (Worsley, McIntyre, Bentall, & Corcoran, 2018; Yates et al., 2012). As an exception, Yates et al. (2012) showed that U.S. college students who experienced more ACEs were more likely to experience PIU. In addition, Arslan (2017) also found that psychological maltreatment contributed to Internet addiction among Turkish young adults. While the results from both adolescents and young adults report an association between ACE and high risk of PIU or mobile phone addiction later in life, few studies have directly considered the relationship between ACEs and PIU specifically in the young adult population (Ioannidis et al., 2018). Therefore, extending this line of research, we hypothesize the following:

Hypothesis 1: ACE correlated with PIU in young adulthood.

While the ACE–PIU relationship may be expected, further investigation into its possible underlying mechanism can help designing appropriate interventions to prevent PIU (Park, Kang, & Kim, 2014; Yates et al., 2012). This expectation is supported by two theoretical viewpoints. First is the I-PACE model (Brand et al., 2016) that depicts a pathway from individual core characteristics to specific Internet-use disorder (e.g., PIU) with several possible mechanisms, including affective and cognitive responses. Second, Kardefelt–Winther's study in 2014 on compensatory Internet use proposes that individual's negative life circumstances motivate them to adopt the Internet, coping with their negative feelings. Consequently, negative feelings may influence the relationship between ACE (i.e., life situation) and PIU. Accordingly, the feeling of loneliness (FOL) were hypothesized as negative emotional state of Internet-related addiction (Jeong, Kim, & Lee, 2017; Mosalanejad, Nikbakht, Abdollahifrad, & Kalani, 2019).

FOL may arise when a person perceives their social companionship to be deficient (Perlman & Peplau, 1981) or feels that their need for social connection/belongingness is unmet (Heinrich & Gullone, 2006). It is particularly prevalent among young adults (18–34 years) (Qualter et al., 2015). Some scholars argued that early negative experiences produce a sense of unworthiness, which can lead to negative emotions such as FOL (Harter, 1998; Loos & Alexander, 1997). Several studies have demonstrated that ACEs are related to FOL (Lin & Chiao, 2020; Luo, Liu, & Zhang, 2020; Wong, Dirghangi, & Hart, 2019). Another study suggested that people engage in addictive behaviors (e.g., PIU) to reduce pain and negative emotions (e.g., FOL) (Burglass, 1988). Moreover, other scholars have even argued that social connection is one of our basic social needs (Hawkley, Thisted, Masi, & Cacioppo, 2010); when this need is unmeet in the real world, it leads to FOL, forcing people to seek the virtual world (Billieux et al., 2013). Empirical evidence has found that FOL increases the risk of PIU (Tian, Bian, Han, Gao, & Wang, 2017; Zhang et al., 2018).

Although limited studies have shown that FOL could potentially influence the ACE–PIU association, research has not examined that FOL can be individualized and dynamic (Jobe-Shields, Cohen, & Parra, 2011). In this regard, a person-centered approach, namely group-based, that groups individuals with similar developmental pathways into finite and distinct groups (Ermer, Segel-Karpas, & Benson, 2020; Schinka, van Dulmen, Mata, Bossarte, & Swahn, 2013), is appropriate for this task with three reasons. First, this approach gives scholars the scope for "creating dense, yet comprehensible description[s] of groups of people through time," while summarizing complex longitudinal data to reduce their complexity (Nagin & Odgers, 2010, 2014, p. 209). Second, the person-centered approach enables a more comprehensive understanding of the focal attribute (e.g., FOL) and some distant outcomes (e.g., PIU). Thirdly, this approach provides an empirical ground for clinical intervention by helping scholars identify the predictors and outcomes of specific subgroups (Vanhalst, Goossens, Luyckx, Scholte, & Engels, 2013).

FOL has multiple distinct trajectories from childhood to adolescence (Harris, Qualter, & Robinson, 2013; Jobe-Shields et al., 2011; Qualter et al., 2013; Schinka et al., 2013; Vanhalst et al., 2013). For example, Jobe-Shields et al. (2011) used a longitudinal sample of elementary school children and classified them into three groups (i.e., "stable low", "increasing", and "decreasing"), wherein the increasing group exhibited elevated risks of developing internalizing symptoms. While subsequent studies have suggested more groups, they showed that the increasing group had high risk of negative outcomes (e.g., depression and low self-rated health) (Harris et al., 2013; Qualter et al., 2013; Vanhalst et al., 2013).

Given the results of previous studies on the association between ACE, FOL, and PIU, and the trajectory of FOL, we further propose the following hypotheses:

Hypothesis 2: ACE correlated with a risky FOL trajectory.

Hypothesis 3: ACE correlated with PIU through a risky FOL trajectory.

METHODS

Participants

The data were drawn from the Taiwan Youth Project (TYP) surveys, conducted in two phases by the Institute of Sociology, Academia Sinica, Taiwan. The first phase began in 2000, surveying adolescents at mean age of 14 from northern Taiwan. Follow-up surveys were conducted for all these participants annually for nine years. In the second phase, the recruited participants who responded to the last survey of the first phase (the response rate was 74%) continued in 2011, 2014 and until 2017 (Lin & Chiao, 2020).

This study was restricted to those who responded to the 2017 survey (i.e., from when information on PIU was available), provided baseline information on ACE, and had one of their parents participating in the baseline survey (n = 2,440). After excluding individuals who did not provide full information on all the items (n = 147), we obtained our final sample of 2,293 participants (94% of all 2,017 participants). A series of comparisons between the final and the excluded participants did not show significant differences in terms of PIU, ACE and FOL trajectories, and the covariates after Bonferroni tests with one exception: the excluded samples were more likely to have substance use at the baseline. The participants self-reported on most of the variables, although some ACEs were derived from parental reports (see Supporting information, Appendix S, for data collection details).

Measures

PIU in young adulthood, at average age of 31, was an outcome; it was constructed as a sum of five items adopted from Chen's Internet Addiction Scale (Ko et al., 2009), measured in the last wave of the survey. These items (e.g., "I have to cut short my sleep time in order to surf online longer") capture five characteristics of PIU: compulsiveness, excessive use, withdrawal, tolerance, and adverse consequences (Block, 2008). Responses to all items were rated on a four-point scale, with higher scores indicating less likelihood of PIU (a = 0.77). Although the current-five item scale did not indicate a specific cut-off for PIU, we created a PIU group based on a recent national survey in Taiwan (National Development Council, 2017), which indicated that approximately 8.3% of Taiwanese people aged between 30 and 39 years were at a high risk of PIU. In this study, the proportion of PIU-affected sample that was the closest to that national survey was 12.59%, which corresponded with a total score of 15. Consequently, those scored was 15 or higher were coded as 1 and all others were coded as 0.

ACE is a major predictor of PIU (Clements-Nolle & Waddington, 2019; Felitti et al., 1998; Finkelhor, Shattuck, Turner, & Hamby, 2015). In this study, ACE included six categories: abuse, household dysfunction, emotional neglect, social isolation, unsafe community, and low socioeconomic status of the family. The items used to capture these categories were drawn from baseline self-reports of adolescents and their parents (see Supporting information, Table S1, for details). The total ACE scores ranged from 0 to 8.

FOL trajectories were measured across eight surveys with the subjects' ages from 14 to 28 years old. The single-item FOL was referred to as a direct measure (Nicolaisen & Thorsen, 2014). The participants were asked whether they had felt lonely during the past two weeks. FOL was coded as 1 if the participants reported feeling lonely at *slightly serious*, *serious*, and *very serious* levels, while those who reported experiencing *no feelings of being lonely* were coded as 0. Although the current measure may not be ideal, prior research demonstrated that a single-item measure of loneliness and a commonly used scale (e.g., UCLA loneliness scale) had a similar capacity to capture loneliness (Michalska da Rocha, Rhodes, Vasilopoulou, & Hutton, 2018; Newmyer, Verdery, Margolis, & Pessin, 2021). In addition, Lin and Chiao (2020) using the same item and dichotomizing theme found that this measure was correlated with de Jong Gierveld Loneliness scale (2006).

Procedure

Assessment of covariates (measured once at average age of 31). We included three categories of confounders: individual characteristics (early sexual maturation, lack of sleep, class rank, substance use, and self-esteem levels), socio-demographic characteristics (age, sex, residential location, and parental education) and parental control. These variables were assessed based on self-reported data at the baseline (Cerniglia, Cimino, Marzilli, Pascale, & Tambelli, 2020; Lin, Wu, You, Hu, & Yen, 2018; Vigna-Taglianti et al., 2017) (see Supporting information, Table S2, for details; see descriptive statistics in Table 1).

Statistical analysis

We examined whether ACE is longitudinally correlated with young adults' PIU by conducting a logistic regression analysis. ACE was approached from two perspectives: total ACE (e.g., the summation of the above ACE items) and threshold-like (presented by four dummy variables, that is, one, two, three, four or more ACEs) because a review (Hughes et al., 2017) concluded that the presence of four or more ACEs substantially increases individuals' health risks.

To explore the possible loneliness trajectories, we applied group-based trajectory modeling (i.e., semi-parametric mixture modeling) (Nagin & Odgers, 2010, Nagin, 2014). This study employed three criteria of model selections. First, the sample-adjusted Bayesian information criterion (SABIC) was used to assess the model fit with the lowest absolute value indicating the best fitting model among all the models (Tein, Coxe, & Cham, 2013). Second, the Lo–Mendell–Rubin adjusted-likelihood ratio test (LMRA) was used to compare k and k-1 classes with insignificant p-values preferring k-1 class model (Lo, Mendell, & Rubin, 2001). Third, the membership probability for an individual should

Table 1. Descriptive characteristics of the sample used in this study

Variable *ACE measure (at age 14.3)*	Percent or mean (SD)	None PIU Percent or mean (SD)	PIU Percent or mean (SD)
ACE (range: 0–8)	2.06 (2.07)	2.02 (1.42)	2.37 (1.51)
Threshold ACE			
0	12.65	13.25	8.53
1	26.69	27.20	23.21
2	26.47	26.60	25.60
3	17.88	17.45	20.82
4 or more	16.31	15.50	21.84
PIU (at age 31.3)	12.78		
Feeling lonely trajectory groups (age 14.3 to age 27.3)			
Constant low (Ref)	53.25	54.75	43.00
Moderate decline	36.81	36.20	40.96
Increasing	9.94	9.05	16.04
Demographic covariates (at age 14.3)			
Male	52.33	52.25	52.90
Age	14.33 (1.15)	14.34 (1.16)	14.28 (1.12)
Being only child	3.84	3.70	4.78
Parent's education: highest education level among parents in years	11.61 (3.01)	11.63 (3.05)	11.43 (2.77)
Family location:			
Taipei city (Ref)	36.76	37.15	34.13
Taipei county	37.90	37.00	44.03
Yilan county	25.34	25.85	21.84
Substance use	8.24	8.30	7.85
Individual covariates (at aged 14.3)			
Early maturation with regard to pubertal timing	16.48	16.50	16.38
Lack of sleep: average sleep minutes ≦360	30.70	31.20	27.30
Class rank (range: 1–5)	2.97 (1.21)	2.99 (1.21)	2.89 (1.23)
Self-esteem (range: 1–4)	2.75 (0.56)	2.76 (0.56)	2.70 (0.57)
Depressive symptoms (range: 1–5)	1.50 (0.49)	1.48 (0.48)	1.60 (0.56)
Family covariates (at aged 14.3)			
Parental control (range: 1–5)	2.46 (1.20)	2.45 (1.20)	2.54 (1.20)
N	2,293	2,000	293

Note: SD = standard deviation.

be greater than 0.7 (Nagin & Odgers, 2010). We also considered the interpretability and the parsimony of the model (Nagin & Odgers, 2010). Hence, the final model that met the three statistical criteria to form interpretable/meaningful groups would be deemed as best fit. All individuals provided at least three of the eight data points, and missing was dealt with by considering the full information maximum likelihood (Allison, 2002). We then employed an appropriated-regression model to examine the relationship between ACE and the derived groups. Finally, a structural equation modeling investigated how ACEs, loneliness trajectory, and PIU are interrelated using *gsem* in STATA 15.0, but the group-based trajectory used Mplus 7.1.

Ethics

The study procedures were carried out in accordance with the Declaration of Helsinki. The study protocol was approved by the Research Ethics Committee of National Yang Ming Chiao Tung University (Taipei, Taiwan) (IRB number: YM106103E-2). In addition, the datasets generated and analyzed in this study are available at the Survey Research Data Archive (https://srda.sinica.edu.tw/). All participants provided written informed consent at the start of their interviews.

RESULTS

Table 1 shows the descriptive statistics of all the variables. The average ACE was 1.89 and was over 2 for those who later exhibited PIU (mean = 2.37). Only 12.65% of the participants did not experience any ACEs; in contrast, 16.31% experienced four or more ACEs. This figure was higher in the PIU group (21.84%) than the non-PIU group (15.50%). Interestingly, while only 9.94% of the sample was in the increasing FOL trajectory group (more details below), this figure almost doubled for those who later developed PIU (16.04%).

Table 2 shows the main effects of ACEs on PIU after accounting for the aforementioned covariates. In Model 1, ACE was significantly correlated with adults' PIU almost 20 years later (adjusted odds ratio [AOR] = 1.12). That is,

Table 2. Logistic regression of ACEs on PIU[12]

Focal X	Model 1 AOR (95% CI)	Model 2 AOR (95% CI)
ACEs	1.12 (1.02, 1.23)*	
1 ACE (Ref: 0 Aces)		1.28 (0.78, 2.08)
2 ACEs		1.38 (0.85, 2.24)
3 ACEs		1.63 (0.98, 2.71)†
4 or more ACEs		1.75 (1.03, 2.97)*

Note: n = 2,293; †$P < 0.1$, *$P < 0.05$.
[1]Robust standard errors in parentheses.
[2]All models were estimated with individual and socio-demographic characteristics, and parental control.
Abbreviations: AOR = adjust odds ratio; CI = 95% confidence interval.

participants with one more ACE had 11% higher odds of being in the PIU group in young adulthood, suggesting a dose–response effect. Model 2 further examined the possible threshold effects. Those who experienced four or more ACEs during early adolescence were 75% more likely to be in the PIU group (AOR = 1.75).

Table 3 showed the results of group-based trajectory analyses. Based on our statistical criteria, a three-class solution was preferred. In addition, it provided a meaningful summary of the data: constant low (53.25%), moderate decline (36.81%), and increasing (9.94%). Figure 1 depicted these three groups along with the proximate average age. The increasing group did not start as high as the moderate decline group but rose continually and was at the highest risk of FOL during adolescence, making it the riskiest group for PIU.

Table 4 explored the relationship between ACEs and FOL trajectories. Considering the constant low group as the reference, multinomial logistic regression demonstrated that ACE was significantly correlated with the other two groups (moderate decline: relative risk ratio [RRR] = 1.42; increasing: RRR = 1.52). Model 2 revealed that although having one ACE was significantly correlated with the likelihood of being in the two riskier groups, having four or more ACE increased the risk substantially (5–6 times higher) compared to the no ACE group (moderate decline: RRR = 5.12; increasing: RRR = 6.90).

Figure 2 Panel A shows that ACE was marginally correlated with PIU (β = 0.09; [AOR = 1.09]) and significantly correlated with the moderate decline (β = 0.35; [RRR = 1.42]) and increasing groups (β = 0.42; [RRR = 1.52]). However, only the increasing group was significantly correlated with PIU (β = 0.65; [AOR = 1.92]), which indicated a possible mediating effect (MacKinnon & Luecken, 2008). Panel B presents the effects of threshold ACEs on both

Table 3. Statistics for group-based trajectory analysis

# of groups	ABIC	ALMR	% of each group	Membership probability
2	20,644	<0.01 (1 vs. 2)	43.96%; 56.04%	0.85; 0.91
3	20,548	<0.01 (2 vs. 3)	9.92%; 36.65%; 53.43%	0.75; 0.76; 0.89
4[1]	20,490	<0.01 (3 vs. 4)	13.24%; 9.16%; 53.23%; 24.36%	0.87; 0.77; 0.77; 0.65
5[2]	20,489	ns (4 vs. 5)	3.21%; 11.93%; 30.90%; 8.65%; 45.30%	0.49; 0.75; 0.66; 0.75; 0.72

Abbreviation: ABIC = Adjusted Bayesian Information Criterion; ALM = Adjusted Lo-Mendell-Rubin.
[1]Four-class analysis also revealed that some parameters were fixed due to several reasons, such as empty join distribution of categorical variables.
[2]Five-class analysis not only showed fix parameter warnings but and also came to local maximum solutions.

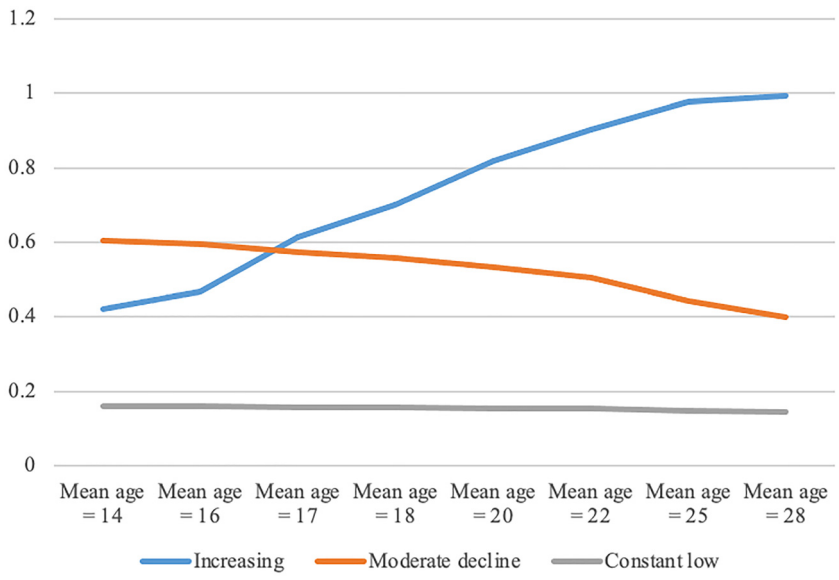

Fig. 1. The results of group based trajectory analysis

Table 4. Multivariate multinomial logistic regression results for loneliness trajectory groups[12]

	Loneliness trajectory Group Contrast[3]			
	Model 1		Model 2	
	Moderate decline RRR (95% CI)	Increasing RRR (95% CI)	Moderate decline RRR (95% CI)	Increasing RRR (95% CI)
Focal X				
ACEs	1.42 (1.32, 1.54)**	1.52 (1.37, 1.71)**		
1 ACE (Ref: 0 Aces)			1.46 (1.03, 2.08)*	1.64 (0.85, 3.15)
2 ACEs			2.43 (1.71, 3.45)**	2.63 (1.38, 5.02)**
3 ACEs			2.78 (1.90, 4.09)**	4.36 (2.25, 8.43)**
4 or more ACEs			5.12 (3.42, 7.68)**	6.90 (3.48, 13.66)**

n = 2,293; †$P < 0.1$, *$P < 0.05$, **$P < 0.01$.
[1]Robust standard errors in parentheses.
[2]All models were estimated with individual and socio-demographic characteristics, and parental control.
Abbreviations: RRR = relative risk ratio; CI = 95% confidence interval.

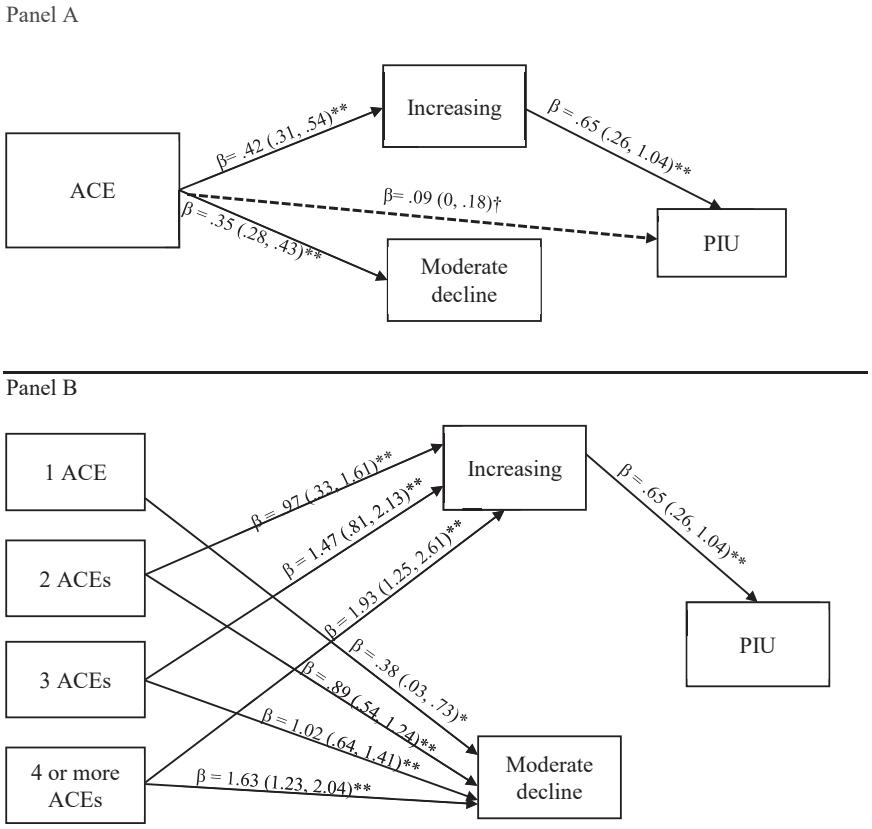

Fig. 2. The relationship between ACE, loneliness group, and PIU (non-significant relationship was not shown for simplicity)

loneliness groups and PIU. After comparing different loneliness groups, we found no direct relationship between ACE and PIU. However, ACE was related to PIU through the increasing group. For instance, adolescents who experienced four or more ACEs were more likely to be in the increasing group (β = 1.93; [RRR = 6.89]), which, in turn, was significantly related to PIU (β = 0.65; [AOR = 2.11]).

We conducted sensitivity analyses with a different cut-off value (total score = 14) because the ratio of this cut-off and the total score for this study (14/20) were identical to that of the cut-off for the high risk of PIU and the total score of the short version (10 items) of Chen's Internet addiction scale (28/40). The results were similar to those presented in the text but with different magnitudes (see Supporting Information, Table S3). In the sensitivity analyses, young adults who experienced ACE were more likely to experience PIU.

DISCUSSION

This study intended to explore how ACEs were related to young adults' PIU. In addition, we incorporated the trajectory

of FOL into this ACE-PIU association, which provided further understanding of PIU in young adulthood. We discussed three important finding in turn. First, our analyses showed a dose–response association between ACE and PIU, even when we controlled for many important covariates. Furthermore, we also found that having four or more ACEs were significantly related to higher risk of PIU. These results supported our first hypothesis and were consistent with the findings of previous studies that directly examined ACE–PIU association (Lim, Cheung, Kho, & Tang, 2019; Li et al., 2020), or the general conclusion from a meta-analysis that revealed that four or more ACEs substantially increased the risk of health issues (Hughes et al., 2017). However, to the best of our knowledge, our study is among the first to include new ACE items (Finkelhor et al., 2015) in young adults.

Consistent with prior research, our findings revealed that ACE is detrimental to both adolescents and young adults. This long-lasting effect has been recognized (Brent & Silverstein, 2013; Shonkoff & Garner, 2012) and Kim et al. (2017) who also indicated that ACE can potentially influence neurotransmitter secretion, such as dopamine or oxytocin, which might make individuals vulnerable to behavioral addiction. Furthermore, Danese and Baldwin (2017) argued that ACEs influence brain function in the domain of positive valence, which influences individual's reward system (e.g., making them less sensitive to rewards). This finding implies that, unlike individuals who had no ACE, those who had ACEs require a higher frequency of Internet to provide similar reward, which increases the possibility of PIU (Danese & Baldwin, 2017).

Second, our analysis suggested three interesting trajectory groups: constant low, moderate decline, and increasing, over almost 15 years. Although the results of our trajectory analysis were not identical to those of previous studies (Qualter et al., 2013; Schinka et al., 2013; Vanhalst et al., 2013), these groups can be found in prior research (Jobe-Shields et al., 2011). For example, Vanhalst et al.'s (2013) "low increasing" group was similar to our increasing group and the two "decreasing" groups were similar to our moderate decline group. The differences could stem from different measurement methods and timeframes. Most previous studies used a scale to capture loneliness, but we used a single item. In addition, our study covered almost 15 years and crossed different life stage (adolescence and young adulthood), whereas previous studies only considered adolescence, and only over 3–10 years (Ladd & Ettekal, 2013). However, we should avoid reifying these groups because they are statistically derived (van Dulmen & Goossens, 2013).

Results also showed that ACE increased the participants' risk of being in the moderate decline and increasing groups, which supported our second hypothesis. These results were similar to several previous studies that have shown that early negative experiences are related to negative emotions including loneliness (Lin & Chiao, 2020; Luo et al., 2020; Wong et al., 2019). However, unlike previous studies, we presented a more vivid picture by showing that ACE increased the risk of not only becoming emotionally lonely in early life (moderate decline) but also of developing a long-term problem (increasing). Brent and Silverstein (2013) indicated that early stress/adversity could influence oxytocin release and/or signaling. As oxytocin affects people's interpersonal processes, affiliation, and feelings of love and trust (Danese & Baldwin, 2017), this early influence could become embedded in the life course, excreting long-term effects. Consequently, ACE is potentially correlated with early loneliness and continually influences one's FOL because of the possible neuroendocrine deficit (Miller, Chen, & Parker, 2011).

To test our third hypothesis, we incorporated FOL groups into the ACE–PIU relationship. The results showed that the direct association between ACE and PIU reduced and became only marginally significant in the case of total ACE and non-significant in the case of threshold like-ACE. However, the increasing group was significantly associated with PIU. Consequently, the results indicated while the presence of ACE may be still associated with adults' PIU, this association largely stems from a long lasting FOL (increasing group). Given few studies on this aspect, we compared our results with studies that analyzed the association between negative early experiences (e.g., maltreatment or stressful life event), emotion-related mediators, and PIU, smart phone (PSU), and social media use (PSM).

Several studies have found that when incorporating negative emotions or emotional regulation, their direct association with PIU or PSM were marginal (Jia et al., 2018) or non-significant (Arslan, 2017; Kircaburun, Griffiths, & Billieux, 2020; Li, Zhang, Li, Zhen, & Wang, 2010; Worsley et al., 2018), which is similar to our results. For example, in the case of high school students, Li et al. (2010) found that the association between a stressful life-event and PIU was not significant after incorporating maladaptive cognition. Similarly, Worsley et al. (2018) found direct but non-significant association between childhood maltreatment and emerging adults' PSM when including depressive symptoms. However, other studies (Emirtekin et al., 2019; Hsieh et al., 2016; Sun, Liu, & Yu, 2019) have found a significant correlation even after including proposed psychopathology and negative emotion.

We offer three possible explanations for these mixed results. First, the effects of early adversity may fade when including more proximal factors in the model and is consistent with Davis' model (2001). Second, most studies have focused on adolescents or younger children; therefore, the time lapse between an adverse experience(s) and PIU was not long. Third, our measure of FOL was time-varying, which summarized the possible change over a long time. Consequently, it may have encapsulated the related negative development (e.g., self-image); hence, it had strong influenced on the ACE–PIU association.

ACE was related to PIU through the increasing FOL group. Specifically, young adults who experienced ACEs were more likely to fall into a more detrimental FOL trajectory group, thereby increasing their odds of having PIU. In general, ACE can potentially influence individuals'

neurotransmitter secretion, which might make them vulnerable to behavioral addictions or inhibit their impulse control (Shonkoff & Garner, 2012). One review (Brent & Silverstein, 2013) showed that early stress influences individuals' behavioral proclivities by modifying the related molecules in the body, leading to constant vigilance or social mistrust. This proclivity is detrimental to building social connections (Kim et al., 2017) and increases the risk of loneliness (Nurius, Green, Logan-Greene, Longhi, & Song, 2016). Consequently, lonely people are more likely to use the Internet to widen their social connections (or seek social support) (Ross & Young, 2009; Sharifpoor, Khademi, & Mohammadzadeh, 2017; Zhang et al., 2018). In addition, individuals may adopt some risky behaviors to increase their social interaction; hence, these responses, including PIU, served not to regulate emotion rather as means to increase social interaction (DeWall & Pond, 2011).

Practical recommendations

Based on our findings, early intervention, such as an ACE awareness campaigns or routine inquiry for adolescents who experience family dysfunction and maltreatment, can have a significant positive impact (Hawkley & Cacioppo, 2010). Also, providing social skills training may help the young adults' risk of falling into the loneliness trajectory, which may influence them to seek virtual connections. Finally, as ACEs may damage one's self-image and consequently increase loneliness, providing early social support to adolescents would help them develop positive experiences and increase resilience (Bethell, Gombojav, & Whitaker, 2019), thereby preventing their early descent into the loneliness trajectory.

Although our study sheds light on adults' PIU, it has some limitations. First, our measure of PIU was limited to the short form of a validated scale; hence, we did not have a proper cut-off. To address this issue, we conducted sensitivity analyses on different cut-off points; however, we cannot fully rule out the possibility of an idiosyncratic cut-off. In addition, the measure of PIU captured Internet usage but ignored the different roles played by various devices, such as computers and smartphones. Second, our measure of loneliness was limited to FOL, but loneliness also includes social loneliness. However, a recent study (citation) showed that one item may also be an effective measure of loneliness (Lacey & Minnis, 2020). Third, our result was only correlational and not causal, even though we had confidence in the relationship between our variables. Finally, external validity may not be ideal because of data limitations.

Our study had several strengths. First, we employed a theoretical approach to longitudinally examine the relationship between ACE, FOL, and PIU. Second, we provided insights into understudied areas, including the etiology of adult PIU and the FOL trajectory. Third, our data included a 15-year follow-up. This allowed us to disentangle the possible relationships between loneliness and PIU to some extent (Zhang et al., 2018).

CONCLUSIONS

Using longitudinal data, we found a dose-response relationship between ACE and adult's PIU. Four or more ACEs placed individuals at a great risk of developing PIU. We then found that ACEs are correlated to high FOL by putting individuals into the increasing loneliness trajectory group. Finally, by increasing individuals' risk of falling into the increasing loneliness trajectory group, ACE significantly increases their odds of developing PIU.

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SUPPLEMENTARY MATERIALS

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REFERENCES

Allison, P. D. (2002). *Missing data*. Thousand Oaks, CA: Sage publications.

Arslan, G. (2017). Psychological maltreatment, forgiveness, mindfulness, and internet addiction among young adults: A study of mediation effect. *Computers in Human Behavior*, *72*, 57–66. https://doi.org/10.1016/j.chb.2017.02.037.

Bethell, C. D., Gombojav, N., & Whitaker, R. C. (2019). Family resilience and connection promote flourishing among US children, even amid adversity. *Health Affairs (Project Hope)*, *38*(5), 729–737. https://doi.org/10.1377/hlthaff.2018.05425.

Billieux, J., Van der Linden, M., Achab, S., Khazaal, Y., Paraskevopoulos, L., Zullino, D., … Thorensc, G. (2013). Why do you play world of warcraft? An in-depth exploration of self-reported motivations to play online and in-game behaviours in the virtual world of Azeroth. *Computers in Human Behavior*, *29*(1), 103–109. https://doi.org/10.1016/j.chb.2012.07.021.

Block, J. J. (2008). Issues for DSM-V: Internet addiction. *American Journal of Psychiatry*, *165*(3), 306–307. https://doi.org/10.1176/appi.ajp.2007.07101556.

Brand, M., Young, K. S., Laier, C., Wölfling, K., & Potenza, M. N. (2016). Integrating psychological and neurobiological considerations regarding the development and maintenance of specific Internet-use disorders: An Interaction of Person-Affect-Cognition-Execution (I-PACE) model. *Neuroscience and Biobehavioral Reviews*, *71*, 252–266. https://doi.org/10.1016/j.neubiorev.2016.08.033.

Brent, D. A., & Silverstein, M. (2013). Shedding light on the long shadow of childhood adversity. *JAMA Network*, *309*(17), 1777–1778. https://doi.org/10.1001/jama.2013.4220.

Burglass, E. M. (1988). The meaning of addiction: Compulsive experience and its interpretation. *Journal of Studies on Alcohol*, *49*(1), 107–108. https://doi.org/10.15288/jsa.1988.49.107.

Caplan, S. E. (2002). Problematic internet use and psychosocial well-being: Development of a theory-based cognitive–behavioral measurement instrument. *Computers in Human Behavior*, *18*(5), 553–575. https://doi.org/10.1016/S0747-5632(02)00004-3.

Caplan, S. E., & High, A. C. (2010). Online social interaction, psychosocial well-being, and problematic Internet use. In K. S. Young, & C. N. de Abreu (Eds.), *Internet addiction: A handbook and guide to evaluation and treatment* (pp. 35–53). Hoboken, NJ: John Wiley & Sons. https://doi.org/10.1002/9781118013991.ch3.

Cerniglia, L., Cimino, S., Marzilli, E., Pascale, E., & Tambelli, R. (2020). Associations among internet addiction, genetic polymorphisms, family functioning, and psychopathological risk: Cross-sectional exploratory study. *JMIR Mental Health*, *7*(12), e17341. https://doi.org/10.2196/17341.

Chern, K. C., & Huang, J. H. (2018). Internet addiction: Associated with lower health-related quality of life among college students in Taiwan, and in what aspects? *Computers in Human Behavior*, *84*, 460–466. https://doi.org/10.1016/j.chb.2018.03.011.

Clements-Nolle, K., & Waddington, R. (2019). Adverse childhood experiences and psychological distress in juvenile offenders: The protective influence of resilience and youth assets. *Journal of Adolescence Health*, *64*(1), 49–55. https://doi.org/10.1016/j.jadohealth.2018.09.025.

Danese, A., & Baldwin, J. R. (2017). Hidden wounds? Inflammatory links between childhood trauma and psychopathology. *Annual Review of Psychology*, *68*, 517–544. https://doi.org/10.1146/annurev-psych-010416-044208.

Davis, R. A. (2001). A cognitive-behavioral model of pathological internet use. *Computers in Human Behavior*, *17*(2), 187–195. https://doi.org/10.1016/S0747-5632(00)00041-8.

DeWall, C. N., & Pond, R. S. (2011). Loneliness and smoking: The costs of the desire to reconnect. *Self and Identity*, *10*(3), 375–385. https://doi.org/10.1080/15298868.2010.524404.

van Dulmen, M. H., & Goossens, L. (2013). Loneliness trajectories. *Journal of Adolescence*, *36*(6), 1247–1249. https://doi.org/10.1016/j.adolescence.2013.08.001.

Emirtekin, E., Balta, S., Sural, I., Kircaburun, K., Griffiths, M. D., & Billieux, J. (2019). The role of childhood emotional maltreatment and body image dissatisfaction in problematic smartphone use among adolescents. *Psychiatry Research*, *271*, 634–639. https://doi.org/10.1016/j.psychres.2018.12.059.

Ermer, A. E., Segel-Karpas, D., & Benson, J. J. (2020). Loneliness trajectories and correlates of social connections among older adult married couples. *Journal of Family Psychology*, *34*(8), 1014–1024. https://doi.org/10.1037/fam0000652.

Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., … Marks, J. S. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The Adverse Childhood Experiences (ACE) Study. *American Journal of Preventive Medicine*, *14*(4), 245–258. https://doi.org/10.1016/s0749-3797(98)00017-8.

Finkelhor, D., Shattuck, A., Turner, H., & Hamby, S. (2015). A revised inventory of adverse childhood experiences. *Child Abuse and Neglect*, *48*, 13–21. https://doi.org/10.1016/j.chiabu.2015.07.011.

Fumero, A., Marrero, R. J., Voltes, D., & Penate, W. (2018). Personal and social factors involved in internet addiction among adolescents: A meta-analysis. *Computers in Human Behavior*, *86*, 387–400. https://doi.org/10.1016/j.chb.2018.05.005.

Gámez-Guadix, M., Calvete, E., Orue, I., & Hayas, C. L. (2015). Problematic internet use and problematic alcohol use from the cognitive–behavioral model: A longitudinal study among adolescents. *Addictive Behaviors*, *40*, 109–114. https://doi.org/10.1016/j.addbeh.2014.09.009.

Harris, R. A., Qualter, P., & Robinson, S. J. (2013). Loneliness trajectories from middle childhood to pre-adolescence: Impact on perceived health and sleep disturbance. *Journal of Adolescence*, *36*(6), 1295–1304. https://doi.org/10.1016/j.adolescence.2012.12.009.

Harter, S. (1998). The development of self-representations. In W. Damon, & N. Eisenberg (Eds.), *Handbook of child psychology: Social, emotional, and personality development* (pp. 553–617). Hoboken, NJ: John Wiley & Sons. http://rehabilitationpsychologist.org/resources/HANDBOOK_OF_CHILD_PSYCHOLOGY_SIXTH_EDITI.pdf.

Hawkley, L. C., & Cacioppo, J. T. (2010). Loneliness matters: A theoretical and empirical review of consequences and mechanisms. *Annals of Behavioral Medicine*, *40*(2), 218–227. https://doi.org/10.1007/s12160-010-9210-8.

Hawkley, L. C., Thisted, R. A., Masi, C. M., & Cacioppo, J. T. (2010). Loneliness predicts increased blood pressure: 5-year cross-lagged analyses in middle-aged and older adults. *Psychology and Aging*, *25*(1), 132–141. https://doi.org/10.1037/a0017805.

Heinrich, L. M., & Gullone, E. (2006). The clinical significance of loneliness: A literature review. *Clinical Psychology Review*, *26*(6), 695–718. https://doi.org/10.1016/j.cpr.2006.04.002.

Hsieh, Y. P., Shen, A. C. T., Wei, H. S., Feng, J. Y., Huang, S. C. Y., & Hwa, H. L. (2016). Associations between child maltreatment, PTSD, and internet addiction among Taiwanese students. *Computers in Human Behavior*, *56*, 209–214. http://doi.org/10.1016/j.chb.2015.11.048.

Hughes, K., Bellis, M. A., Hardcastle, K. A., Sethi, D., Butcgart, A., Mikton, C., … Dunne, M. P. (2017). The effect of multiple adverse childhood experiences on health: A systematic review and meta-analysis. *The Lancet Public Health*, *2*(8), e356–e366. https://doi.org/10.1016/S2468-2667(17)30118-4.

Ioannidis, K., Treder, M. S., Chamberlain, S. R., Kiraly, F., Redden, S. A., Stein, D. J., … Grant, J. E. (2018). Problematic internet use as an age-related multifaceted problem: Evidence from a two-site survey. *Addictive Behaviors*, *81*, 157–166. https://doi.org/10.1016/j.addbeh.2018.02.017.

Jeong, E. J., Kim, D. J., & Lee, D. M. (2017). Why do some people become addicted to digital games more easily? A study of digital game addiction from a psychosocial health perspective. *International Journal of Human–Computer Interaction*, *33*(3), 199–214. https://doi.org/10.1080/10447318.2016.1232908.

Jia, J., Li, D., Li, X., Zhou, Y., Wang, Y., Sun, W., & Zhao, L. (2018). Peer victimization and adolescent Internet addiction: The mediating role of psychological security and the moderating role of teacher-student relationships. *Computers in Human Behavior*, *85*, 116–124. https://doi.org/10.1016/j.chb.2018.03.042.

Jobe-Shields, L., Cohen, R., & Parra, G. R. (2011). Patterns of change in children's loneliness: Trajectories from third through fifth grades. *Merrill-Palmer Quarterly*, *57*(1), 25–47. https://doi.org/10.1353/mpq.2011.0003.

de Jong Gierveld, J., & Van Tilburg, T. (2006). A 6-item scale for overall, emotional, and social loneliness: Confirmatory tests on survey data. *Research on Aging*, *28*(5), 582–598. https://doi.org/10.1177/0164027506289723.

Kardefelt-Winther, D. (2014). A conceptual and methodological critique of internet addiction research: Towards a model of compensatory internet use. *Computers in Human Behavior*, *31*, 351–354. https://doi.org/10.1016/j.chb.2013.10.059.

Kim, S., Kwok, S., Mayes, L. C., Potenza, M. N., Rutherford, H. J., & Strathearn, L. (2017). Early adverse experience and substance addiction: Dopamine, oxytocin, and glucocorticoid pathways. *Annals of the New York Academy of Sciences*, *1394*(1), 74–91. https://doi.org/10.1111/nyas.13140.

Kim, J. Y., Wineinger, N. E., & Steinhubl, S. R. (2016). The influence of wireless self-monitoring program on the relationship between patient activation and health behaviors, medication adherence, and blood pressure levels in hypertensive patients: A substudy of a randomized controlled trial. *Journal of Medical Internet Research*, *18*(6), e116. https://doi.org/10.2196/jmir.5429.

Kircaburun, K., Griffiths, M. D., & Billieux, J. (2020). Childhood emotional maltreatment and problematic social media use among adolescents: The mediating role of body image dissatisfaction. *International Journal of Mental Health and Addiction*, *18*, 1536–1547. https://doi.org/10.1007/s11469-019-0054-6.

Kitazawa, M., Yoshimura, M., Murata, M., Sato-Fujimoto, Y., Hitokoto, H., Mimura, M., … Kishimoto, T. (2018). Associations between problematic Internet use and psychiatric symptoms among university students in Japan. *Psychiatry and Clinical Neurosciences*, *72*(7), 531–539. https://doi.org/10.1111/pcn.12662.

Ko, C. H., Yen, J. Y., Chen, S. H., Yang, M. J., Lin, H. C., & Yen, C. F. (2009). Proposed diagnostic criteria and the screening and diagnosing tool of Internet addiction in college students. *Comprehensive Psychiatry*, *50*(4), 378–384. https://doi.org/10.1016/j.comppsych.2007.05.019.

Lacey, R. E., & Minnis, H. (2020). Practitioner review: Twenty years of research with adverse childhood experience scores–advantages, disadvantages and applications to practice. *Journal of Child Psychology and Psychiatry*, *61*(2), 116–130. https://doi.org/10.1111/jcpp.13135.

Laconi, S., Kaliszewska-Czeremska, K., Gnisci, A., Sergi, I., Barke, A., Jeromin, F., … Kuss, D. J. (2018). Cross-cultural study of Problematic Internet Use in nine European countries. *Computers in Human Behavior*, *84*, 430–440. https://doi.org/10.1016/j.chb.2018.03.020.

Ladd, G. W., & Ettekal, I. (2013). Peer-related loneliness across early to late adolescence: Normative trends, intra-individual trajectories, and links with depressive symptoms. *Journal of Adolescence*, *36*(6), 1269–1282. https://doi.org/10.1016/j.adolescence.2013.05.004.

Leménager, T., Hoffmann, S., Dieter, J., Reinhard, I., Mann, K., & Kiefer, F. (2018). The links between healthy, problematic, and addicted Internet use regarding comorbidities and self-concept-related characteristics. *Journal of Behavioral Addictions*, *7*(1), 31–43. https://doi.org/10.1556/2006.7.2018.13.

Lim, M. S., Cheung, F. Y., Kho, J. M., & Tang, C. K. (2019). Childhood adversity and behavioural addictions: The mediating role of emotion dysregulation and depression in an adult community sample. *Addiction Research and Theory*, *28*(2), 116–123. https://doi.org/10.1080/16066359.2019.1594203.

Lin, W. H., & Chiao, C. (2020). Adverse adolescence experiences, feeling lonely across life stages and loneliness in adulthood. *International Journal of Clinical and Health Psychology*, *20*(3), 243–252. https://doi.org/10.1016/j.ijchp.2020.07.006.

Lin, M. P., Wu, J. Y., You, J., Hu, W. H., & Yen, C. F. (2018). Prevalence of internet addiction and its risk and protective factors in a representative sample of senior high school students in Taiwan. *Journal of Adolescence*, *62*, 38–46. https://doi.org/10.1016/j.adolescence.2017.11.004.

Li, W., Zhang, X., Chu, M., & Li, G. (2020). The impact of adverse childhood experiences on mobile phone addiction in Chinese college students: A serial multiple mediator model. *Frontiers in Psychology*, *11*, 834. https://doi.org/10.3389/fpsyg.2020.00834.

Li, D., Zhang, W., Li, X., Zhen, S., & Wang, Y. (2010). Stressful life events and problematic internet use by adolescent females and males: A mediated moderation model. *Computers in Human Behavior*, *26*(5), 1199–1207. https://doi.org/10.1016/j.chb.2010.03.031.

Lo, Y., Mendell, N. R., & Rubin, D. B. (2001). Testing the number of components in a normal mixture. *Biometrika*, *88*(3), 767–778. https://doi.org/10.1093/biomet/88.3.767.

Loos, M. E., & Alexander, P. C. (1997). Differential effects associated with self-reported histories of abuse and neglect in a college sample. *Journal of Interpersonal Violence*, *12*(3), 340–360. https://doi.org/10.1177/088626097012003002.

Luo, S., Liu, Y., & Zhang, D. (2020). Psychological maltreatment and loneliness in Chinese children: The role of perceived social support and self-esteem. *Children and Youth Services Review*, *108*, 104573. https://doi.org/10.1016/j.childyouth.2019.104573.

Lynch, J., & Smith, G. D. (2005). A life course approach to chronic disease epidemiology. *Annual Review of Public Health*, *26*, 1–35. https://doi.org/10.1146/annurev.publhealth.26.021304.144505.

MacKinnon, D. P., & Luecken, L. J. (2008). How and for whom? Mediation and moderation in health psychology. *Health Psychology*, *27*(2S), S99–S100. https://doi.org/10.1037/0278-6133.27.2(Suppl.).S99.

McEwen, B. S. (1998). Protective and damaging effects of stress mediators. *The New England Journal of Medicine*, *338*(3), 171–179. https://doi.org/10.1056/NEJM199801153380307.

Michalska da Rocha, B., Rhodes, S., Vasilopoulou, E., & Hutton, P. (2018). Loneliness in psychosis: A meta-analytical review.

Schizophrenia Bulletin, *44*(1), 114–125. https://doi.org/10.1093/schbul/sbx036.

Miller, G. E., Chen, E., & Parker, K. J. (2011). Psychological stress in childhood and susceptibility to the chronic diseases of aging: Moving toward a model of behavioral and biological mechanisms. *Psychological Bulletin*, *137*(6), 959–997. https://doi.org/10.1037/a0024768.

Mosalanejad, L., Nikbakht, G., Abdollahifrad, S., & Kalani, N. (2019). The prevalence of smartphone addiction and its relationship with personality traits, loneliness and daily stress of students in Jahrom university of medical sciences in 2014: A cross-sectional analytical study. *Journal of Research in Medical and Dental Science*, *7*(2), 131–136.

Nagin, D. S. (2014). Group-based trajectory modeling: An overview. *Annals of Nutrition and Metabolism*, *65*, 205–210. https://doi.org/10.1159/000360229.

Nagin, D. S., & Odgers, C. L. (2010). Group-based trajectory modeling in clinical research. *Annual Review of Clinical Psychology*, *6*, 109–138. https://doi.org/10.1146/annurev.clinpsy.121208.131413.

National Development Council (2017). *2017 Internet addiction survey*. Taiwan: National Development Council. Retrieved from https://ws.ndc.gov.tw/Download.ashx?u=LzAwMS9hZG1pbmlzdHJhdG9yLzEwL2NrZmlsZS83MjVlOTBlOC1iZWVjLTQ0NzgtODA0MC1hNjBlYzEyYjMwNDkucGRm&n=MTA25bm057ay6Lev5rKJ6L%2B3LnBkZg%3D%3D.

Newmyer, L., Verdery, A. M., Margolis, R., & Pessin, L. (2021). Measuring older adult loneliness across countries. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *76*(7), 1408–1414. https://doi.org/10.1093/geronb/gbaa109.

Nicolaisen, M., & Thorsen, K. (2014). Who are lonely? Loneliness in different age groups (18–81 years old), using two measures of loneliness. *The International Journal of Aging and Human Development*, *78*(3), 229–257. https://doi.org/10.2190/AG.78.3.b.

Nurius, P. S., Green, S., Logan-Greene, P., Longhi, D., & Song, C. (2016). Stress pathways to health inequalities: Embedding ACEs within social and behavioral contexts. *International Public Health Journal*, *8*(2), 241–256. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4891624/.

Pan, P. Y., & Yeh, C. B. (2018). Internet addiction among adolescents may predict self-harm/suicidal behavior: A prospective study. *The Journal of Pediatrics*, *197*, 262–267. https://doi.org/10.1016/j.jpeds.2018.01.046.

Park, S., Kang, M., & Kim, E. (2014). Social relationship on problematic internet use (PIU) among adolescents in South Korea: A moderated mediation model of self-esteem and self-control. *Computers in Human Behavior*, *38*, 349–357. https://doi.org/10.1016/j.chb.2014.06.005.

Perlman, D., & Peplau, L. A. (1981). Toward a social psychology of loneliness. In R. Gilmour, & S. Duck (Eds.), *Personal relationships, Volume 3: Personal relationships in disorder* (pp. 31–56). London: Academic Press. https://peplau.psych.ucla.edu/wp-content/uploads/sites/141/2017/07/Perlman-Peplau-81.pdf.

Qualter, P., Brown, S. L., Rotenberg, K. J., Vanhalst, J., Harris, R. A., Goossens, L., … Munn, P. (2013). Trajectories of loneliness during childhood and adolescence: Predictors and health outcomes. *Journal of Adolescence*, *36*(6), 1283–1293. https://doi.org/10.1016/j.adolescence.2013.01.005.

Qualter, P., Vanhalst, J., Harris, R., Roekel, E. V., Lodder, G., Bangee, M., … Verhagen, M. (2015). Loneliness across the life span. *Perspectives on Psychological Science*, *10*(2), 250–264. https://doi.org/10.1177/1745691615568999.

Ross, H. E., & Young, L. J. (2009). Oxytocin and the neural mechanisms regulating social cognition and affiliative behavior. *Frontiers in Neuroendocrinology*, *30*(4), 534–547. https://doi.org/10.1016/j.yfrne.2009.05.004.

Schinka, K. C., van Dulmen, M. H., Mata, A. D., Bossarte, R., & Swahn, M. (2013). Psychosocial predictors and outcomes of loneliness trajectories from childhood to early adolescence. *Journal of Adolescence*, *36*(6), 1251–1260. https://doi.org/10.1016/j.adolescence.2013.08.002.

Sharifpoor, E., Khademi, M. J., & Mohammadzadeh, A. (2017). Relationship of internet addiction with loneliness and depression among high school students. *International Journal of Psychology and Behavioral Sciences*, *7*(4), 99–102. https://doi.org/10.5923/j.ijpbs.20170704.01.

Shonkoff, J. P., & Garner, A. S., & Committee on Psychosocial Aspects of Child and Family Health, Committee on Early Childhood, Adoption, and Dependent Care, & Section on Developmental and Behavioral Pediatrics (2012). The lifelong effects of early childhood adversity and toxic stress. *Pediatrics*, *129*(1), e232–e246. https://doi.org/10.1542/peds.2011-2663.

Spada, M. M. (2014). An overview of problematic Internet use. *Addictive Behaviors*, *39*(1), 3–6. https://doi.org/10.1016/j.addbeh.2013.09.007.

Sun, J., Liu, Q., & Yu, S. (2019). Child neglect, psychological abuse and smartphone addiction among Chinese adolescents: The roles of emotional intelligence and coping style. *Computers in Human Behavior*, *90*, 74–83. https://doi.org/10.1016/j.chb.2018.08.032.

Tein, J. Y., Coxe, S., & Cham, H. (2013). Statistical power to detect the correct number of classes in latent profile analysis. *Structural Equation Modeling: A Multidisciplinary Journal*, *20*(4), 640–657. https://doi.org/10.1080/10705511.2013.824781.

Tian, Y., Bian, Y., Han, P., Gao, F., & Wang, P. (2017). Associations between psychosocial factors and generalized pathological internet use in Chinese university students: A longitudinal cross-lagged analysis. *Computers in Human Behavior*, *72*, 178–188. https://doi.org/10.1016/j.chb.2017.02.048.

Vanhalst, J., Goossens, L., Luyckx, K., Scholte, R. H., & Engels, R. C. (2013). The development of loneliness from mid-to late adolescence: Trajectory classes, personality traits, and psychosocial functioning. *Journal of Adolescence*, *36*(6), 1305–1312. https://doi.org/10.1016/j.adolescence.2012.04.002.

Vigna-Taglianti, F., Brambilla, R., Priotto, B., Angelino, R., Cuomo, G., & Diecidue, R. (2017). Problematic internet use among high school students: Prevalence, associated factors and gender differences. *Psychiatry Research*, *257*, 163–171. https://doi.org/10.1016/j.psychres.2017.07.039.

de Vries, H. T., Nakamae, T., Fukui, K., Denys, D., & Narumoto, J. (2018). Problematic internet use and psychiatric co-morbidity in a population of Japanese adult psychiatric patients. *BMC Psychiatry*, *18*(1), 1–10. https://doi.org/10.1186/s12888-018-1588-z.

Wong, A. E., Dirghangi, S. R., & Hart, S. R. (2019). Self-concept clarity mediates the effects of adverse childhood experiences on adult suicide behavior, depression, loneliness, perceived stress, and life distress. *Self and Identity*, *18*(3), 247–266. https://doi.org/10.1080/15298868.2018.1439096.

Worsley, J. D., McIntyre, J. C., Bentall, R. P., & Corcoran, R. (2018). Childhood maltreatment and problematic social media use: The role of attachment and depression. *Psychiatry Research*, *267*, 88–93. https://doi.org/10.1016/j.psychres.2018.05.023.

Yang, C. K., Choe, B. M., Baity, M., Lee, J. H., & Cho, J. S. (2005). SCL-90-R and 16PF profiles of senior high school students with excessive internet use. *The Canadian Journal of Psychiatry*, *50*(7), 407–414. https://doi.org/10.1177/070674370505000704.

Yates, T. M., Gregor, M. A., & Haviland, M. G. (2012). Child maltreatment, alexithymia, and problematic internet use in young adulthood. *Cyberpsychology, Behavior, and Social Networking*, *15*(4), 219-225. https://doi.org/10.1089/cyber.2011.0427.

Zhang, S., Tian, Y., Sui, Y., Zhang, D., Shi, J., Wang, P., … Si, Y. (2018). Relationships between social support, loneliness, and internet addiction in Chinese postsecondary students: A longitudinal cross-lagged analysis. *Frontiers in Psychology*, *9*, 1707. https://doi.org/10.3389/fpsyg.2018.01707.