Mental health profile and health-related behavior among Hong Kong Chinese university students

Cecilia MS Ma and Catie CW Lai

Abstract

To better understand factors that are associated with individuals' engagement in physical activity and other health-related behaviors, this study aimed to identify the psychological well-being profiles among Chinese university students, and explore whether engagement in physical activity and other health-related behaviors vary with different psychological well-being profiles. A battery of self-report questionnaires was completed by 2022 Chinese university students for assessing psychological well-being and health-related behaviors. Four psychological well-being profiles were identified. The vast students were mentally healthy. The students with better mental health displayed lower likelihood of engagement in unhealthy behaviors. Findings and implication of the study were discussed.

Keywords

health behavior, latent profile analysis, lifestyle, physical activity, well-being

Introduction

Unhealthy behaviors, including substance use, physical inactivity, and suicide, have become some of the most pressing public health concerns. Physical inactivity accounts for approximately 25 percent of cancer and 30 percent of heart diseases (World Health Organization (WHO), 2009). Substance use, such as smoking, is the leading cause of premature mortality (Centers for Disease Control and Prevention, 2013). Among college students, suicide is the second leading cause of preventable death (Barnes et al., 2010). As such, research that identifies the correlates of participation in these unhealthy behaviors could have important public health implications.

Well-being is defined as the extent to which an individual can function positively with respect to mental health (Ryff and Singer, 2008). Research has indicated that positive well-being (e.g. happiness, life satisfaction) serves as a protective factor against health risk behaviors during the developmental transition (Hoyt et al., 2012). For example, happier college students were found to be more physically active, reported less consumption of drugs, such as marijuana (Piqueras et al., 2011), and predicted fewer risky behaviors (Grant et al., 2009). Meanwhile, researchers also explored how ill-being (e.g. psychological distress and

mental health problems) is related to risky behaviors among university students. Past research shows that negative psychological constructs (e.g. depression, hopelessness, and loneliness) are associated with risk-related behaviors, such as drinking (Cranford et al., 2009) and marijuana use (Moore et al., 2007). Cross-sectional evidence has shown that depressed and hopeless individuals are likely to smoke more (Lai and Ma, 2016), be less physically active (Taliaferro et al., 2009; Tyson et al., 2010), and have more suicidal thoughts (Hawton et al., 2013). A cross-cultural study with college students from 21 countries gave support to the negative association between life satisfaction and smoking, suicide, and physical inactivity level (Grant et al., 2009). In addition, higher level of loneliness is associated with more frequent substance use (i.e. smoking and drug use), increased risk of suicide ideation, and less physically

The Hong Kong Polytechnic University, Hong Kong

Corresponding author:
Cecilia MS Ma, Department of Applied Social Sciences, The Hong Kong Polytechnic University, HJ431, Hung Hom, Kowloon, Hong Kong.
Email: cecilia.ma@polyu.edu.hk

active (Hawkley et al., 2009; Lasgaard et al., 2011; Stickley et al., 2013, 2014) Although psychological constructs have been associated with a variety of unhealthy behaviors, most of the studies have adopted a variable-centered approach when testing such relationships (e.g. Hawton et al., 2013; Stickley et al. 2013). This might limit the ability to capture the patterns of psychological well-being of individuals (Aldridge and Roesch, 2008).

Many studies gave support for the co-occurrences of multiple psychological constructs. For example, youth with high hope reported significantly greater life satisfaction than youth with average or low hope (Gilman et al., 2006). Depressed adults and individuals with high loneliness consistently show low life satisfaction (Proctor et al., 2009). There is also a strong association between loneliness and depression among young, mid-life, and older adults (Victor and Yang, 2012). Some researchers have suggested identifying different psychological profiles for a comprehensive understanding of the complex interplay between various psychological constructs (Chan et al., 2011). For example, Crockett et al. (2006) identified five psychological profiles based on self-regulation, proneness to risk, self-worth, and perceived academic competence. They, in turn, found that those psychological profiles were significantly associated with substance use, engagement in delinquency, and sexual risk-taking.

Hoyt et al. (2012) argue that both positive and negative psychological constructs should not be studied in isolation and suggest the need to consider the combination effects on physical health outcomes (Pressman and Cohen, 2005). In particular, it is likely informative to study the relationship between psychological constructs and unhealthy behaviors by using person-centered approaches. The latent profile analysis (LPA) is recommended to identify different patterns of psychological well-being constructs within a heterogeneous sample (Marsh et al., 2009). Compared to the traditional clustering methods, there are several strengths of this approach. First, it provides us with a more objective way to decide the optimal number of class membership by assessing several fit indices from competing models (Pastor et al., 2007). Second, it explores the homogeneous pattern of response on specified variables based on a probability of membership in each subgroup (Muthén and Asparouhov, 2007). Finally, unlike the traditional variable-centered approaches, this method improves statistical inference by identifying the latent subgroups and modeling the measurement error in the observed indicators by using the observed indicators (Sterba and Bauer, 2010; Vermunt, 2008).

As mentioned earlier, individuals' well-being should be seen as a combination of multiple psychological constructs. This study sought to extend the literature by exploring the psychological well-being profiles exhibited by a sample of Chinese university students and by assessing qualitative differences in their health behaviors based on their class memberships. The findings of the study shed light on identifying which psychological well-being profile is deemed vulnerable and designing appropriate intervention or program to grapple with unhealthy behaviors (e.g. smoking, drinking).

Methods

Participants

Data were collected through a non-credit-bearing healthy lifestyle program at a public university in Hong Kong. Before the program, participants were asked to complete a physical fitness test in a large auditorium in August 2014. Once they finished the fitness test, they were invited to complete the survey in a quiet and private place. Participants were 2022 Chinese university students (male: $n = 965$, 47.7%; female: $n = 1057$, 52.2%). The mean of age was 18.73 (standard deviation (SD) = 1.29). Most of them were Chinese ($n = 1896$, 94%), freshmen ($n = 1952$, 96.7%), and lived off-campus ($n = 1316$, 65.5%). Written informed consent was sought from the participants. This study obtained ethical approval from the University Review Board.

Measures

Happiness. Happiness was measured by the WHO-5 Well-Being Index (Topp et al., 2015). The scale has been well validated and used in different cultures (Topp et al., 2015). Participants were invited to indicate their judgment of their feeling over the past 2 weeks using a 6-point Likert-type scale, with a higher score indicating a higher level of positive well-being. The internal consistency of the scale was adequate ($\alpha = .81$).

Life satisfaction. Life satisfaction was measured by the Satisfaction with Life Scale (Diener et al., 1985). The scale comprises five items. Participants were invited to indicate their judgment of their quality of life using a 6-point Likert-type scale, with a higher score indicates a higher level of life satisfaction. The internal consistency of the scale was satisfactory ($\alpha = .75$).

Hopelessness. Hopelessness was measured by the Chinese version of 5-item Hopelessness Scale (Shek, 1993). Responses were indicated on a 6-point scale ranging from 0 (not present) to 5 (constantly present). This scale has been used in many studies with Chinese samples (e.g. Lai and Ma, 2016). The internal consistency of the scale was satisfactory ($\alpha = .75$).

Depression. The depressive symptoms were measured by Patient Health Questionnaire-9 (Spitzer et al., 1999). Previous work has supported the construct validity and reliability of this scale (Yu et al., 2012). Responses were provided on a 4-point Likert-type scale, ranging from 0 (not at all) to

3 (nearly every day). The internal consistency of the scale was good ($\alpha = .86$).

Loneliness. Loneliness was measured by the UCLA Loneliness Scale (ULS-8; Hays and DiMatteo, 1987). This scale was validated for Chinese culture (Wu and Yao, 2008). Responses were provided on a 6-point Likert-type scale, ranging from 1 (strongly disagree) to 6 (strongly agree). The internal consistency of the scale was good ($\alpha = .86$).

Substance use and suicide. Four items were used to ask the frequency of substance use, including (1) cigarette, (2) marijuana, (3) methamphetamine, and (4) other illegal drugs over the past 3 months. One item was used to ask the frequency of having suicidal thoughts over the past 3 months. Responses ranged from 0 = never in my lifetime, 1 = never in the past three months, 2 = once in the past three months, 3 = two to three times in the past three months, 4 = one to two times per week, 5 = three to four times per week to 6 = more than five times per week.

Physical inactivity. One item was used to ask the frequency of participation in moderate-to-vigorous, minimum 30-minute physical activity (e.g. jogging, swimming, cycling, and playing basketball) over the past 7 days. Responses ranged from 0 (never) to 7 (over 7 times).

Demographic information. Participants were asked to report their age and gender (male = 0; female = 1).

Data analysis

Before performing the LPA, all measures were validated through a series of confirmatory factor analysis (CFA). Several fit indices were used to test how well the models fit the data, including the comparative fit index (CFI), the Tucker–Lewis index (TLI), the standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA). The following criteria were adopted to determine whether the model was acceptable: values of CFI and TLI greater than .90 or above (Kline, 2005) and values of RMSEA and SRMR below .08 and .06, respectively (Hu and Bentler, 1999).

For LPA, different profile models (1 group to 5 groups) were tested to explore the best fitting model (i.e. the most appropriate number of latent groups). To choose the best fitting model, several indices were used, including Akaike's (1987) Information Criterion (AIC), Schwarz's (1978) Bayesian Information Criterion (BIC), and the adjusted BIC (ABIC). For all indices, lower values suggest a better fit of the data. The Lo–Mendell–Rubin likelihood ratio test (LMRT; Lo et al., 2001) was used to compare the models of *k*-class and *k*-1 class (Wang and Wang, 2012). Significant *p* values ($p < .05$) indicate a better fit of the *k*-class model than that of the *k*-1 class model. Also, entropy was examined to

assess how well the latent classes of individuals are classified based on posterior class membership probabilities (Clark, 2010). High values of entropy indicate better classification. The statistics were examined to determine the final model. The maximum likelihood estimation with robust standard errors (MLR) was used to estimate model parameters. Once the optimal latent class solution is selected, age and gender were tested as covariates in the "AUXILIARY" statement in *Mplus* version 7.4 (Asparouhov and Muthén, 2013; Muthén and Muthén 1998-2007). Similar to a multinomial logistic regression model, this method would not affect latent class classification (Wang and Wang, 2012). To avoid local maxima, all models were estimated with 2000 random sets of starting values and 500 iterations (Hipp and Bauer, 2006; Pastor et al., 2007). Also, *z*-scores of the psychological well-being variables were computed to interpret the latent class membership from a theoretical perspective. The covariance coverage exceeds the minimum threshold (ranging from .925 to .998; Muthén and Muthén, 2010).

To test any differences in problem behaviors based on the class membership–dependent variables, logistic regressions were used to determine whether these latent classes differed on problem behaviors (i.e. smoking, drinking, drug use, physical activity level, and suicide) via SPSS version 23. Odds ratio together with the corresponding 95 percent confidence interval (CI) are used as estimates of effect measures.

Results

The factor structure of depression, life satisfaction, and hopelessness has been supported in the previous study (Lai and Ma, 2016). The one-factor model of loneliness did not fit the model ($\chi^2(20) = 1050.214$; $p < .01$, RMSEA = .16 (90% CI = .15–.17), CFI = .86, TLI = .80, SRMR = .06). Three pairs of error covariance were suggested to be correlated as was reflected by the high values of the modification indices (ranging from 162.93 to 484.48). These parameters were set free in the modified model, which fitted the data better ($\chi^2(17) = 233.742$; $p < .01$, RMSEA = .08 (90% CI = .07–.09), CFI = .97, TLI = .95, SRMR = .03). Similar results were shown in the one-factor model of happiness with a pair of error covariance ($\chi^2(17) = 84.536$; $p < .01$, RMSEA = .10 (90% CI = .08–.12), CFI = .99, TLI = .96, SRMR = .02). The internal consistency of these variables was acceptable. All variables were significantly related ($p < .01$, see Table 1).

## Identification of the number of latent class

The 4-class solution fitted the data better compared to 1- and 2-class solutions, as indicated by the lower values of AIC, BIC, and ABIC. In terms of the *p* value of the two ratio tests (Vuong–Lo–Mendell–Rubin likelihood ratio (VLMR) and

Table 1. Descriptive statistics, internal consistencies, and correlations of variables.

	Whole sample	α	1	2	3	4	5
	M (SD)						
Happiness	3.28 (.81)	.81	–				
Hopelessness	1.15 (.97)	.75	−.42**	–			
Life satisfaction	3.10 (.91)	.75	.71**	−.37**	–		
Loneliness	2.54 (.68)	.86	−.26**	.34**	−.25**	–	
Depression	1.02 (.60)	.86	−.41**	.51**	−.34**	−.32**	–
Missing values (%)			.1	.4	.6	.4	7

SD: standard deviation.
**$p < .01$.
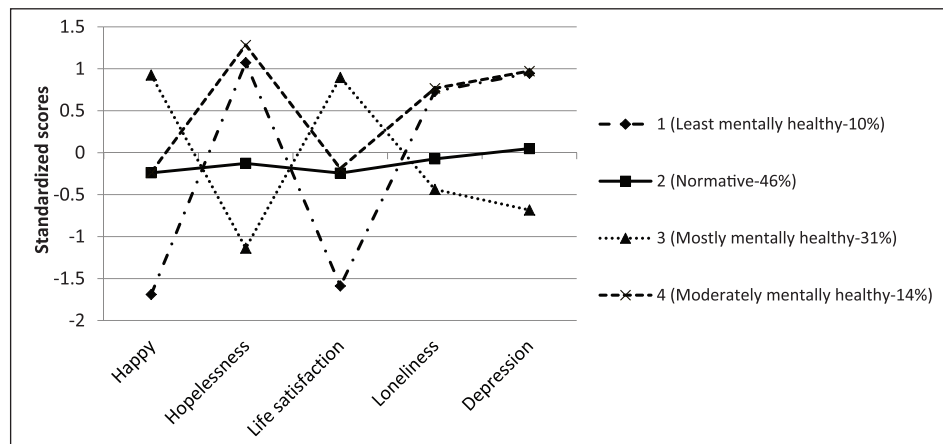
Figure 1. Profile characteristics of the four latent classes.

Lo–Mendell–Rubin adjusted (LMR-A)), no statistical significance was found between 3- and 4-class solutions. However, high entropy value for the 4-class solution, indicating 4-class solution, provided a better-fitting model. In addition, the average latent class probability for the most likely latent class membership by latent class discrimination showed acceptable fit (above .70 in the diagonal values and below .10 in the off-diagonal values; Muthén and Muthén 1998–2001). The 5-class solution, despite its acceptable values of the information indexes (AIC, BIC, ABIC, VLMR, LMR-A, bootstrapped likelihood ratio test (BLRT), and entropy), was rejected as two classes had less than 4 percent of cases (Table 2). Therefore, a 4-class solution was deemed optimal.

According to the participants' profiles, students in Class 1 (the least mentally healthy group) showed negative psychological well-being (above average in hopelessness, loneliness, and depression, below average in happiness and life satisfaction). They demonstrated high levels of hopelessness ($M=2.20$, standard error (SE)=.06), loneliness ($M=3.16$, $SE=.08$), and depression ($M=1.58$, $SE=.07$) and low levels of happiness ($M=1.91$, $SE=.27$) and life satisfaction ($M=1.65$, $SE=.21$). Students in Class 2 (normative group) were normative (average in all psychological well-being variables). They showed moderate levels of happiness

($M=3.08$, $SE=.06$) and life satisfaction ($M=2.88$, $SE=.07$) and low levels of loneliness ($M=2.61$, $SE=.06$), depression ($M=1.05$, $SE=.05$), and hopelessness ($M=1.03$, $SE=.08$). Students in Class 3 (the most mentally healthy group) showed good psychological well-being with highest levels of happiness ($M=4.03$, $SE=.06$) and life satisfaction ($M=3.92$, $SE=.06$) and lower levels of hopelessness ($M=0.05$, $SE=.05$), loneliness ($M=2.37$, $SE=.02$) and depression ($M=0.61$, $SE=.04$). Students in Class 4 (moderately mentally healthy group) showed moderate levels of happiness ($M=3.73$, $SE=.05$) and life satisfaction ($M=3.73$, $SE=.05$) and highest levels of hopelessness ($M=2.40$, $SE=.31$), loneliness ($M=3.19$, $SE=.09$), and depression ($M=1.60$, $SE=.07$). The latent profile means for psychological well-being by each outcome for each class are shown in Table 3. The z-scores of all four latent classes are shown in Figure 1.

Gender was a significant demographic covariate in predicting class membership. Compared to males, females had lower odds of being in Class 1 (the least mentally healthy group, $\beta=-.24$, $SE=.08$, $p<.01$), Class 3 (mostly mentally healthy group, $\beta=-.44$, $SE=.14$, $p<.01$), and Class 4 (moderately mentally healthy group, $\beta=-.61$, $SE=.20$, $p<.01$). This significant demographic effect was not found in age ($p>.05$).

Table 2. Results of latent profile analysis (LPA).

No. of class	AIC	BIC	ABIC	VLMR p value	LMR-A p value	BLRT p value	Entropy	Class size: n (%)
1	26,425.398	26,492.513	26,454.388	–	–	–	–	Class 1: 1984 (100%)
2	20,448.200	20,537.686	20,486.853	.0000	.0000	<.0000	.724	Class 1: 808 (41%) Class 2: 1176 (59%)
3	20,020.655	20,143.699	20,073.804	.2064	.2116	<.0000	.695	Class 1: 355 (18%) Class 2: 1056 (53%) Class 3: 573 (29%)
4	19,707.264	19,863.864	19,774.907	.1394	.1428	<.0000	.734	Class 1: 190 (10%) Class 2: 950 (48%) Class 3: 605 (30%) Class 4: 239 (12%)
5	19,488.433	19,678.590	19,570.571	1.000	1.000	<.0000	.772	Class 1: 53 (3%) Class 2: 490 (25%) Class 3: 897 (45%) Class 4: 486 (24%) Class 5: 58 (3%)

AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; ABIC: Adjusted BIC; VLMR: Vuong–Lo–Mendell–Rubin likelihood ratio test; LMR: Lo–Mendell–Rubin adjusted likelihood ratio test; BLRT: bootstrapped likelihood ratio test.

Table 3. Estimated means and standard errors of the four psychological well-being profiles.

Class	Happiness M (SE)	Hopelessness M (SE)	Life satisfaction M (SE)	Loneliness M (SE)	Depression M (SE)
1 (Least mentally healthy)	1.91 (.27)	2.20 (.06)	1.65 (.21)	3.16 (.08)	1.58 (.07)
2 (Normative group)	3.08 (.06)	1.03 (.08)	2.88 (.07)	2.61 (.06)	1.05 (.05)
3 (Mostly mentally healthy)	4.03 (.06)	0.05 (.05)	3.92 (.06)	2.37 (.02)	0.61 (.04)
4 (Moderately mentally healthy)	3.09 (.06)	2.40 (.31)	2.93 (.29)	3.19 (.09)	1.60 (.07)

Table 4. Results from the logistic regressions of the health-related behaviors based on the class membership.

Class	1 Least mentally healthy (10%) OR (CI)	2[a] Normative (46%) OR (CI)	3 Mostly mentally healthy (31%) OR (CI)	4 Moderately mentally healthy (14%) OR (CI)
Smoke	1.46 (0.62–3.44)	Ref.	1.08 (0.58–2.03)	2.74** (1.43–5.24)
Drugs	4.98 (0.70–35.60)	Ref.	2.30 (0.38–13.80)	22.57** (4.97–102.22)
Physical inactivity	1.02 (0.49–2.12)	Ref.	2.32** (1.55–3.47)	2.32** (1.38–3.89)
Suicide	4.04** (2.40–6.81)	Ref.	0.32** (0.15–0.69)	2.85** (1.68–4.83)

[a]Normative group (Class 2) as reference group.
**$p <.01$

Logistic regression was used to test the differences in the health-related behaviors (smoking, substance use, engage in physical activity, and suicide) between each class. Results showed that students in Class 4 reported higher odds in smoking (2.74 times), substance use (22.57 times), physical inactivity (2.32 times), and suicide attempts (2.85 times) compared to Class 2 (reference group). Class 3 students reported lower odds in suicide attempts (0.32 times) and physical inactivity (2.32 times). Class 1 students reported significantly higher odds in suicide attempts (4.04 times). All logistic regression results are shown in Table 4.

Discussion

To date, little research has been done to empirically identify subgroups of psychological well-being among a sample of Chinese university students by employing a latent profile approach. This study attempted to fill this research gap and

to elucidate how these distinct subgroups differed in terms of the problem behaviors.

In this study, four distinct classes were found. Class 2 (normative group) was the largest of all the classes and was marked by moderate levels of happiness, loneliness, and depression and lower levels of hopelessness and life satisfaction. Class 3 (the most mentally healthy group) had the second highest proportion of students with highest levels of positive well-being (happiness and life satisfaction) and lowest levels of negative well-being (hopelessness, loneliness, and depression). This showed that the majority of Chinese young adults were mentally healthy. Class 4 (moderately mentally healthy group), comprised 14 percent of the university students, reported higher levels of hopelessness, loneliness, and depression and a moderate level of happiness and life satisfaction. Finally, Class 1 (the least mentally healthy group), comprised 10 percent of the university students, reported highest levels of hopelessness, loneliness, and depression and lowest levels of happiness and life satisfaction. The current findings are aligned with a recent study by Ling et al. (2015), who found three latent classes when studying Chinese adolescents' emotional and behavioral problems. The presence of these four distinct groups provides evidence for the limitations of the two-group (i.e. healthy and unhealthy) traditional medical model (e.g. Suldo and Shaffer, 2008) and elucidates the heterogeneity of psychological well-being among a sample of Chinese young adults. Our study demonstrates the importance of using a person-centered approach when studying the well-being of individuals.

Another purpose of this study was to explore how students of different latent classes differ in their health-related behavior. Consistent with the past research (Piqueras et al., 2011), both mentally healthy groups (Classes 2 and 3) were less likely to engage in problematic behaviors and adopt an active lifestyle and such results are. Students in these two groups were happier and more optimistic and had fewer negative psychological outcomes and depressive symptoms. This made them less likely to engage in unhealthy behaviors and physical inactivity.

Compared to the students in Classes 2 and 3, students with higher scores of loneliness and depressive symptoms (Classes 1 and 4) were more likely to engage in unhealthy behaviors. This is in line with prior research showing the linkages between poor psychological health outcomes and unhealthy behaviors, such as smoking (e.g. Mykletun et al., 2008), suicide attempts (Kisch et al., 2005), and substance use (Goodwin et al., 2014). In particular, psychological distress in early adulthood predicts the onset of later psychological distress and substance use (Marmorstein et al., 2010; Weitzman, 2004). Given that most of the research exploring the relationship between psychological well-being and unhealthy behaviors has been predominantly conducted in western countries, this study extends the literature to a new population. Despite the presence of negative psychological well-being (depression, hopelessness,

and loneliness), Class 4 students were happier and more optimistic than their Class 1 counterparts. It is noteworthy that this group exhibited a higher likelihood of smoking and suicidal behaviors. This suggests that practitioners need to focus more on this subgroup when designing campus-based mental health programs.

To date, few studies have simultaneously explored the effects of both positive and negative well-being on health-related behaviors using a person-centered approach. Four distinct profiles of psychological well-being were found, ranging from less vulnerable to very vulnerable to mental health problems. Our findings of the co-occurrence of positive and negative affect support the theory that these aspects are a continuum rather than two distinct dimensions (Headey, 2006). This study provides practical implications for educators and counselors in tertiary education. In this transition period, college students may suffer from stress related to academic and social demands of their new environment (Misra and Castillo, 2004). They are likely to engage in unhealthy behaviors to relieve their stress (Gehricke et al., 2007). In particular, negative psychological well-being has also been linked to the risk of multiple problem behaviors, including substance use (Haardörfer et al., 2016), physical inactivity (Leslie et al., 2001), and suicidality (Weber et al., 1997) and was evidenced in our study. The results from this study highlight the importance of raising the mental health literacy among college students, who are less likely to seek treatment due to the possible social stigma (Eisenberg et al., 2011). Perhaps, more efforts to improve college students' knowledge of mental health and to reduce the risks leading to the problem behaviors are warranted.

Nevertheless, the limitations of this study should be noted. Our findings were based on Hong Kong Chinese university students. To assess the generalizability of the current findings, future study should be conducted in other Chinese societies. The study was based on a cross-sectional design; therefore, causal conclusion cannot be concluded. Further longitudinal investigation of the stability of the patterns of multiple psychological well-being outcomes throughout the college years is recommended.

Despite the above limitations, there are several strengths in this study. First, a large sample was used in the study. Second, a person-centered approach was used to discern the patterns of psychological well-being among Chinese university students. Third, the present findings extended the literature in understanding how different latent groups are related to health-related behaviors. Finally, well-validated scales of psychological well-being have been used. The uniqueness of this study was the use of a person-centered approach that uncovered the distinct psychological well-being profiles and model measurement errors (Collins and Lanza, 2010). Findings from this study extended the literature by providing a descriptive picture of young adults' psychological well-being at this transition period. It allows

health providers to tailor specific and successful intervention programs or counseling services to meet the needs of this target group (Wilcox et al., 2010).

Declaration of conflicting interests

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References

Akaike H (1987) Factor analysis and AIC. *Psychometrika* 52: 317–332.

Aldridge A and Roesch SC (2008) Developing coping typologies of minority adolescents: A latent profile analysis. *Journal of Adolescence* 31: 499–517.

Asparouhov T and Muthén B (2013) Auxiliary variables in mixture modeling: 3-stop approaches using Mplus. Mplus Web Notes: No. 15, Version 7. Available at: http://www.statmodel.com/examples/webnotes/webnote15.pdf (Accessed 18 November 2016).

Barnes DH, Golden RN and Peterson FL (2010) *The Truth about Suicide*. New York: Infobase Publishing.

Centers for Disease Control and Prevention (2013) Vital signs: Current cigarette smoking among adults aged ⩾18 years with mental illness-United States, 2009–2011. *MMWR* 62: 81–87.

Chan MF, Creedy DK, Chua TL, et al. (2011) Exploring the psychological health related profile of nursing students in Singapore: A cluster analysis. *Journal of Clinical Nursing* 20: 3553–3560.

Clark SL (2010) *Mixture modeling with behavioral data*. Doctoral dissertation, University of California, Los Angeles, CA.

Collins LM and Lanza ST (2010) *Latent Class and Latent Transition Analysis: With Applications in the Social, Behavioral, and Health Sciences*. New York: John Wiley & Sons.

Cranford JA, Eisenberg D and Serras AM (2009) Substance use behaviors, mental health problems, and use of mental health services in a probability sample of college students. *Addictive Behaviors* 34: 134–145.

Crockett LJ, Moilanen KL, Raffaelli M, et al. (2006) Psychological profiles and adolescent adjustment: A person-centered approach. *Development and Psychopathology* 18: 195–214.

Diener E, Emmons R, Larsen R, et al. (1985) The Satisfaction with Life Scale. *Journal of Personality Assessment* 49: 71–75.

Eisenberg D, Hung J, Speer N, et al. (2011) Mental health service utilization among college students in the United States. *Journal of Nervous and Mental Disease* 1999: 301–308.

Gehricke JG, Loughlin SE, Whalen CK, et al. (2007) Smoking to self-medicate attentional and emotional dysfunctions. *Nicotine & Tobacco Research* 9(Suppl. 4): S523–S536.

Gilman R, Dooley J and Florell D (2006) Relative levels of hope and their relationship with academic and psychological indicators among adolescents. *Journal of Social and Clinical Psychology* 25: 166–178.

Goodwin RD, Grinberg A, Shapiro J, et al. (2014) Hookah use among college students: Prevalence, drug use, and mental health. *Drug and Alcohol Dependence* 141: 16–20.

Grant N, Wardle J and Steptoe A (2009) The relationship between life satisfaction and health behavior: A cross-cultural analysis of young adults. *International Journal of Behavioral Medicine* 16: 259–268.

Haardörfer R, Berg C, Lewis M, et al. (2016) Polytobacco, marijuana, and alcohol use patterns in college students: A latent class analysis. *Addictive Behaviors* 59: 58–64.

Hawkley LC, Thisted RA and Cacioppo JT (2009) Loneliness predicts reduced physical activity: Cross-sectional & longitudinal analyses. *Health Psychology* 28: 354–363.

Hawton K, i Comabella CC, Haw C, et al. (2013) Risk factors for suicide in individuals with depression: A systematic review. *Journal of Affective Disorders* 147: 17–28.

Hays RD and DiMatteo MR (1987) A short-form measure of loneliness. *Journal of Personality Assessment* 51: 69–81.

Headey BW (2006) *Happiness: Revising Set Point Theory and Dynamic Equilibrium Theory to Account for Long-Term Change*. Berlin: DIW German Institute for Economic Research.

Hipp JR and Bauer DJ (2006) Local solutions in the estimation of growth mixture models. *Psychological Methods* 11: 36–53.

Hoyt LT, Chase-Lansdale PL, McDade TW, et al. (2012) Positive youth, healthy adults: Does positive well-being in adolescence predict better perceived health and fewer risky health behaviors in young adulthood? *Journal of Adolescent Health* 50: 66–73.

Hu L and Bentler PM (1999) Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling* 6: 1–55.

Kisch J, Leino EV and Silverman MM (2005) Aspects of suicidal behavior, depression, and treatment in college students: Results from the spring 2000 national college health assessment survey. *Suicide and Life-Threatening Behavior* 35: 3–13.

Kline RB (2005) *Principles and Practice of Structural Equation Modeling* (2nd edn). New York: Guilford Press.

Lai CCW and Ma CMS (2016) The mediating role of social support in the relationship between psychological well-being and health-risk behaviors among Chinese university students. *Health Psychology Open*. Epub ahead of print 8 November. DOI: 10.1177/2055102916678106.

Lasgaard M, Goossens L and Elklit A (2011) Loneliness, depressive symptomatology, and suicide ideation in adolescence: Cross-sectional and longitudinal analyses. *Journal of Abnormal Child Psychology* 39: 137–150.

Leslie E, Fotheringham MJ, Owen N, et al. (2001) Age-related differences in physical activity levels of young adults. *Medicine and Science in Sports and Exercise* 33: 255–258.

Ling Y, Huebner ES, Yuan H, et al. (2015) Subtyping of strengths and difficulties in a Chinese adolescent sample: A latent class analysis. *Child Indicators Research* 9: 933–948.

Lo Y, Mendell N and Rubin D (2001) Testing the number of components in a normal mixture. *Biometrika* 88: 767–778.

Marmorstein NR, Iacono WG and Malone SM (2010) Longitudinal associations between depression and substance dependence from adolescence through early adulthood. *Drug and Alcohol Dependence* 107: 154–160.

Marsh H, Lüdtke O, Trautwein U, et al. (2009) Classical latent profile analysis of academic self-concept dimensions: Synergy of person-and variable-centered approaches to theoretical models of self-concept. *Structural Equation Modeling: A Multidisciplinary Journal* 16(2): 191–225.

Misra R and Castillo LG (2004) Academic stress among college student: Comparison of American and International students. *International Journal of Stress Management* 11: 132–148.

Moore TH, Zammit S, Lingford-Hughes A, et al. (2007) Cannabis use and risk of psychotic or affective mental health outcomes: A systematic review. *Lancet* 370: 319–328.

Muthén BO and Asparouhov T (2007) Wald test of mean equality for potential latent class predictors in mixture modeling. Retrieved from http://www.statmodel.com/download/MeanTest1.pdf (accessed 19 April 2011).

Muthén LK and Muthén BO (2010) *Mplus user's guide* (6th edn). Los Angeles, CA: Muthén & Muthén.

Mykletun A, Overland S, Aarø LE, et al. (2008) Smoking in relation to anxiety and depression: Evidence from a large population survey: The HUNT study. *European Psychiatry* 23: 77–84.

Pastor DA, Barron KE, Miller BJ, et al. (2007) A latent profile analysis of college students' achievement goal orientation. *Contemporary Educational Psychology* 32: 8–47.

Piqueras JA, Kuhne W, Vera-Villarroel P, et al. (2011) Happiness and health behaviors in Chilean college students: A cross-sectional survey. *BMC Public Health* 11: 443–452.

Pressman SD and Cohen S (2005) Does positive affect influence health? *Psychological Bulletin* 131: 925–971.

Proctor CL, Linley PA and Maltby J (2009) Youth life satisfaction: A review of the literature. *Journal of Happiness Studies* 10: 583–630.

Ryff CD and Singer BH (2008) Know thyself and become what you are: A eudaimonic approach to psychological well-being. *Journal of Happiness Studies* 9: 13–39.

Shek DTL (1993) Measurement of pessimism in Chinese adolescents: The Chinese hopelessness scale. *Social Behavior and Personality* 21: 107–119.

Spitzer RL, Kroenke K and Williams JBW (1999) Validation and utility of a self-report version of PRIME-MD: The PHQ primary care study. *Journal of the American Medical Association* 282: 1737–1744.

Sterba SK and Bauer DJ (2010) Matching method with theory in person-oriented developmental psychopathology research. *Development and Psychopathology* 22: 239–254.

Stickley A, Koyanagi A, Koposov R, et al. (2014) Loneliness and health risk behaviours among Russian and US adolescents: A cross-sectional study. *BMC Public Health* 14: 1–12.

Stickley A, Koyanagi A, Roberts B, et al. (2013) Loneliness: Its correlates and association with health behaviours and outcomes in nine countries of the former Soviet Union. *PLoS ONE* 8: e67978.

Suldo SM and Shaffer EJ (2008) Looking beyond psychopathology: The dual factor model of mental health in youth. *School Psychology Review* 37: 52–68.

Taliaferro LA, Rienzo BA, Pigg RM, et al. (2009) Associations between physical activity and reduced rates of hopelessness, depression, and suicidal behavior among college students. *Journal of American College Health* 57: 427–436.

Topp CW, Østergaard SD, Søndergaard S, et al. (2015) The WHO-5 well-being index: A systematic review of the literature. *Psychotherapy and Psychosomatics* 84: 167–176.

Tyson P, Wilson K, Crone D, et al. (2010) Physical activity and mental health in a student population. *Journal of Mental Health* 19: 492–499.

Vermunt JK (2008) Latent class and finite mixture models for multilevel data sets. *Statistical Methods in Medical Research* 17: 33–51.

Victor CR and Yang K (2012) The prevalence of loneliness among adults: A case study of the United Kingdom. *The Journal of Psychology* 146: 85–104.

Wang J and Wang X (2012) Mixture modeling. In: Balding DJ (ed.) *Structural Equation Modeling: Applications Using Mplus*. New York: John Wiley & Sons, pp. 289–390.

Weber B, Metha A and Nelsen E (1997) Relationship among multiple suicide ideation risk factors in college students. *Journal of College Student Psychotherapy* 11: 49–64.

Weitzman ER (2004) Poor mental health, depression, and associations with alcohol consumption, harm, and abuse in a national sample of young adults in college. *The Journal of Nervous and Mental Disease* 192: 269–277.

Wilcox HC, Arria AM, Caldeira KM, et al. (2010) Prevalence and predictors of persistent suicide ideation, plans, and attempts during college. *Journal of Affective Disorders* 127: 287–294.

World Health Organization (WHO) (2009) Global health risks: Mortality and burden of disease attributable to selected major risks. Available at: http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf (accessed 6 October 2016).

Wu CH and Yao G (2008) Psychometric analysis of the short-form UCLA Loneliness Scale (ULS-8) in Taiwanese undergraduate students. *Personality and Individual Differences* 44: 1762–1771.

Yu X, Tam WWS, Wong PTK, et al. (2012) The patient health questionnaire-9 for measuring depressive symptoms among the general population in Hong Kong. *Comprehensive Psychiatry* 53: 95–102.