



Problematic utilization of online social networking site in Chinese college students: prediction of personality and dynamic mediators

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Abstract

Utilization of online social networking sites (SNSs) is often problematic in young people. However, studies seldom seek to understand personal differences and deep-seated reasons in its problematic utilization. This study aims to explore the longstanding and recent psychosocial predictors of problematic utilization of WeChat friend center (PUWF) longitudinally. A total of 433 college students (17–25 years old, male/female ratio: 389/44) were investigated over 2 successive years (T1: first year; T2: second year) using the Sixteen Personality Factor Questionnaire, Adolescent Self-Rating Life Events Checklist, Social Support Scale, Patient Health Questionnaire, Connor-Davidson Resilience Scale, and the problematic utilization scale of the WeChat friend center which was developed in this study. Correlation, regression, and structural equation analyses were conducted. A problematic utilization scale of the WeChat friend center was developed with Cronbach's alpha of .836. 21.02% of students reported WeChat PUWF. Males utilized the WeChat friend center less than females, and females were at higher risk of PUWF, which was correlated with worse mental health. In the longitudinal prediction, regression and modeling analyses showed that apprehension of personality predicted PUWF consistently and directly, and this was partially mediated by T1 depression and T2 negative life events. Results suggest that females are at higher risk for PUWF. Apprehension personality has a direct and indirect effect on PUWF through recent depression and life events. The findings help to recognize individuals at risk for PUWF as well as to better prevent it, and provide suggestions as to the functional design of SNSs according to different need of users. Core tips: Utilization of SNSs is often problematic in young people. However, personal differences and deep-seated reasons in its problematic utilization has been poorly revealed. Through a longitudinal investigation, this study confirms that females are at higher risk for PUWF. Apprehension personality has a direct and indirect effect on PUWF through recent depression and life events. The findings help to recognize individuals at risk for PUWF and give theoretical evidence to the functional design of SNSs for different users.

Keywords Problematic utilization · Online social networking site · Personality · Life events · Depression · Gender differences

Excessive electronic device and Internet use in China has attracted more and more attention from psychological researchers (Tran et al., 2020). The overall prevalence of smartphone ownership is 41% in China, while Hong Kong has the highest number of adolescents reporting daily or

above Internet use (68%) (Mak et al., 2014). Although online social networking sites (SNSs) are popular worldwide, little research has addressed personal preferences and deep-seated reasons in the utilization and preference of these. WeChat is a popular online SNS in Eastern countries, especially in China. With more than 110 million users worldwide, WeChat is equivalent to Facebook in Western countries in its function, which allows text, video, photo, or other information communication between users, as well as real-life interaction such as paying or shopping. However, research on the utilization of WeChat is sparse. In WeChat, the friend center is a unique, optional social part that allows interaction between WeChat connectors through posting pictures or news, browsing, making comments, and so on.

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This differs from direct conversation in SNSs, and one can choose to enter or not to enter, to share or not to share, and to browse or not to browse the friend center. Sometimes, the utilization of WeChat was mandatory for the sake of working group within WeChat and utilization of WeChat for most friends. Therefore, the utilization of optional friend center of WeChat could better reflect personal preference in online social networking sites. Early adulthood is a critical developmental transition from adolescence to adulthood, during which social relationships (especially peer relationships) influence the mental health of young adults significantly (Gutiérrez-García et al., 2017). This may also alter their tendency to use the friend center on SNS. However, no research to date has explored the utilization of WeChat friend center in early adulthood.

Uses and gratifications approach

Based on the Uses and Gratifications approach (Katz et al., 1974), it has been pointed out that “the audience is conceived as active”; i.e., users are goal-directed in their selection of communication media. That is to say, a unique kind of communication media that people used is generated from their specific needs based on personality or personal/contextual situations. Previously, different types of gratifications have been explored in problematic Internet use: social, entertainment, etc. (Carpentier et al., 2019; Li, 2019; Tanrikulu & Erdur-Baker, 2019). We thus considered less exploring implicit and explicit needs that constantly have an impact in guiding an individual’s media preference: stable personality traits and dynamic personal/contextual factors (Katz et al., 1974).

Moreover, the effect of personality on Internet use might be mediated by less stable and more dynamic factors from the personal and contextual domains of each individual (Hou et al., 2018; Katz et al., 1974; Tang et al., 2014; Zhou et al., 2017); both contain a risk and resilience framework (Cains & Henshel, 2021; Kiss & Piko, 2019), which allows risk assessors to distill a complex issue into a manageable model that quantifies the effects of an adverse stressor, and forms a solution-based assessment with the incorporation of adaptive management of systematic resilience; i.e., vulnerable (depression, life events) and protective (resilience, social support) factors of personal and contextual status decide personal need jointly.

Prediction of personality and potential mediators

Personality

In relation to stable personality traits, previous studies have confirmed that personality plays a role in problematic

Internet use (Hou et al., 2018; Munno et al., 2017; Zhou et al., 2018), such as neuroticism (Hou et al., 2018) and self-esteem (Zeng et al., 2021). Neuroticism is frequently reported in this regard (Hou et al., 2018; Zhou et al., 2018) but other personality traits less so. It was found that excessive Internet users are easily affected by negative feelings and are emotionally less stable (i.e., apprehension) (Yang et al., 2005). Apprehension is a kind of personality trait, which is described as self-doubting, worried, guilt-prone, insecure, worrying, and self-blaming (Cattell, 1956). In particular, communication apprehension was found to be significantly related to social media problematic utilization (Punyanunt-Carter et al., 2018). Trait-like communication apprehension was consistently found to predict Facebook use (Zhang et al., 2011). Although the findings to date confirm a role of *apprehension* as a personality trait which might be the basis for the personality needs relating to Internet use, its contribution to the preferences of individuals in using the online social networking sites, especially the problematic utilization of the WeChat friend center (PUWF), remains unclear. Online social networking is different from general Internet utilization, and SNS is more focused on social purpose instead of ordinary Internet utilization such as gaming or entertainment.

Personal mental health

Based on the literature, findings regarding the association between mental health and Internet use have been mixed, especially for resilience (as a protective factor) and depression (as a risk factor) (Choi et al., 2015; Nishida et al., 2019; Yen et al., 2019). Specifically, individuals with problematic gaming have been found to have lower resilience which had a moderating effect (Canale et al., 2019). However, some study did not confirm the prediction of resilience on problematic Internet or smartphone use (Choi et al., 2015). It deserves to be pointed out that psychologists have a major concern about whether problematic gaming can or should be attributed to a new disorder, since there is lack of consensus on its assessment (Aarseth et al., 2017; van Rooij et al., 2018). Moreover, relationship between problematic smartphone use and depressive mood has also been mixed (Choi et al., 2015; Elhai et al., 2017; Nishida et al., 2019). Some study confirmed that there was a significant and positive correlation between depression and Internet problematic use (Peterka-Bonetta et al., 2019) and depression acted as a mediator (Przepiorka et al., 2021). One investigation indicated that the longer hours adolescents spent for online chat were associated with depression only in females but not in males (Nishida et al., 2019). However, in another study, depression was found a protective factor of problematic smartphone use (Choi et al., 2015). Thus, although an indecisive involvement of personal mental health (specifically

resilience as a protective factor and depression as a risk factor) has been indicated in problematic Internet use, its influence and mediation effect on the PUWF remain unexplored. This knowledge helps to identify vulnerable populations (e.g., lower resilience, higher depression) for PUWF who had stronger psychological need for excessive social interaction.

Contextual factors

Dynamic contextual factors include social support (as a protective factor) and life events (as a risk factor). Research has shown that social support plays an important role in determining the “liking” behavior of WeChat users (C.M., 2017, Hou et al., 2018; Pang, 2018). Excessive use of Weibo and WeChat correlates negatively with social support and social interaction (Hou et al., 2018). The association between perfectionism and problem Internet use was fully mediated by the perception of low social support (Casale et al., 2014). After controlling for demographics and personality traits, stressful life events have been found to positively correlate with problematic Internet use (Xiao et al., 2019), and adolescents with problematic Internet use report more stressful life events (Koenig et al., 2016). Consistently, the mediating effect of life events on problematic Internet use has been confirmed (Tang et al., 2014; Yang et al., 2014). Extensively, stressful life events (Koenig et al., 2016; Xiao et al., 2019) or perceived stresses (Boer et al., 2020) make a unique contribution to problematic Internet use in adolescent and that should be considered in the prevention of adolescent problematic Internet use. Although a role of contextual factors (protective social support and risk life events) as discussed here on Internet use has been confirmed, their impact and mediation effects on the utilization of the PUWF are unknown, since SNS use was more focused on social function and different from general Internet use. This knowledge might benefit to identify individuals at higher risk (e.g., less social support, more life events) for PUWF who had stronger psychological need for excessive social interaction.

Dynamics

Importantly, dynamic personal factors (resilience and depression) and contextual factors (social support and life events) are time-varying (Ormel & Neeleman, 2000), and their influence may be short (simultaneously, or days to weeks) or medium (months to a year) in duration. However, the statuses of dynamic factors (i.e., life events) have often been observed and reported once instead of multi-time observation (Ormel & Neeleman, 2000). Thus, their influence could only be reflected by stability of variables, while the dynamic variation of variables (life events, social support, and resilience) has not been revealed. Notably,

the status of previous depression constantly predicted later depression significantly (Keenan et al., 2009), which was not reflected in previous mediating predictions (Ormel et al., 2001). Moreover, a combined longitudinal prediction model consisting of personality traits, personal mental health (resilience and depression), and the contextual factors of social support and life events on the PUWF needs to be tested. PUWF might lead to inadequate or excessive utilization of SNS, and result in poor mental health, so it would be beneficial and important to identify the precursors of PUWF in order to prevent these negative outcomes of problematic use. The results warranted a multi-time point observation of dynamic life events, social support, depression, and resilience in the prediction of PUWF. The longitudinal prediction knowledge is potentially important to identify the risk populations for PUWF and further help to develop preventative or therapeutic interventions for PUWF through focusing on vulnerable factors.

Gender

The variable gender has been frequently reported in relation to Internet use, with a gender difference in spending time online (Dufour et al., 2016; Vigna-Taglianti et al., 2017). Specifically, males often reported more Internet problematic utilization and Smartphone use (Choi et al., 2015), as well as Internet abuse (Munno et al., 2017), than females. However, whether a gender difference exists in the utilization of the friend center on SNS in early adulthood is unknown, which is potentially important to recognize the vulnerable gender (i.e., male) for PUWF and further prevent it.

The present study

Based on the Uses and Gratifications theory, this study intended to observe the implicit personality need for PUWF. Second, dynamic psychosocial need for PUWF generating from depression, resilience, life events, and social support was also investigated. Third, gender differences for PUWF were also observed which reflected inner gender need. This study contributed to identify implicit personality basis and potential mediators for PUWF and then to better prevent it through paying more attention to these vulnerable factors.

In summary, based on the Uses and Gratifications approach, the current study had three aims. The first was to confirm the prediction of apprehension personality on PUWF longitudinally. The second was to further explore potential dynamic psychosocial mediators between personality and PUWF. The third was to observe potential gender differences in the utilization of the WeChat friend center during early adulthood. Our hypotheses were as follows:

First, individuals with personality trait—apprehension—would report more PUWF.

Second, personal mental health (specifically resilience and depression) would mediate (mute or exaggerate, respectively) the effect of personality on PUWF.

Third, contextual factors (specifically social support and life events) would mediate (mute or exaggerate, respectively) the effect of personality on PUWF.

Fourth, it was expected that males were at higher risks associated with PUWF compared with females.

Method

Participants

A total of 492 College freshmen living on a campus in Chongqing, China, were recruited¹ in 2017. They were all Chinese, Han nationality, without working or part-time job. Students were invited verbally and in writing. Responders who agreed to participate signed on written informed consent to enter this 2-year longitudinal study, which was approved by the Human Research Ethics Committee of the Army Medical University. Participants were further screened by psychologists to exclude current or previous substance/alcohol misuse or Axis I psychiatric disorders using the Structured Clinical Interview of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) (APA, 2000). Exclusion criteria included learning disabilities and severe physical trauma, having taken any psychological medication, generalized anxiety disorder, bipolar disorder, lifetime or current psychotic symptoms, and substance alcohol or dependency or abuse within the past 6 months. A total of 433 college students (88.01% of total sample) completed the 2-year longitudinal investigation (males = 389, females = 44; age range 17–25 years old, mean = 18.93 ± 1.41), and received class credit for their participation. Due to participants were in a military medical university, and they are all major in clinical medicine, there were more male participants than female participants.

¹ To calculate the sample size for ratio investigation of problematic use of friend center of WeChat, the following equation was used with G*Power 3 (Faul et al., 2007): $N = Z_{1-\alpha/2}^2(1-p)/\epsilon^2p$.

$P = 0.2474$ (Meena et al., 2012), $\epsilon = 0.05$, $\alpha = 0.05$, $Z_{1-\alpha/2} = 1.96$. $N = 1.96^2 * (1 - 0.2474) / 0.05^2 * 0.2474 = 286.112$.

Faul, F., Erdfelder, E., Lang, A.G., Buchner, A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods*, 2007, 39(2): 175–91.

Meena et al. (2012). Problematic use of social networking sites among urban school going teenagers. *Ind Psychiatry J*, 21, 94–97.

Development of the problematic utilization scale of the wechat friend center

Several social media disorder scales existed in China (Fung, 2019). However, none of them targeted the friend center of WeChat—an optional part of SNS, which is different from general SNS, as discussed previously, and warranted a new scale to observe its problematic utilization.

Based on the literature, problematic utilization of Internet was often defined as excessive or prolonged time spending on Internet (Hou et al., 2018; Meena et al., 2012; Zhou et al., 2018) or inadequate utilization of specific part of Internet such as gaming or gambling (Derevensky et al., 2019; Yen et al., 2019). After a formal interview with three psychologists (three professors were invited: they were required to have a doctoral degree, major in psychology, and be familiar with problematic utilization of Internet; all of them were willing to participate in the discussion, one of them was a member of the current project), the formal component of the current PUWF questionnaire was confirmed as excessive or prolonged time spending on the WeChat friend center. Thus, this scale did not contain the three factors in Internet addiction test (withdrawal and social problems, time management and performance, reality substitute) (Lai et al., 2013), since the friend center of WeChat is different from general Internet utilization, and is not well corresponding to the three factors of Internet addiction.

Based on the content of PUWF, we designed a specific scale titled the problematic utilization scale of WeChat friend center. The initial version was designed referring to Young's Internet problematic utilization test (Young, 1996), since both scales were correlated with problematic utilization of intellectual media, and four items in the Chinese version of Young's Internet problematic utilization diagnostic questionnaire (Li et al., 2012) were also introduced. All items were self-reported and each question required a “no” or “yes” response, scored 0 and 1, respectively. Higher scores represented higher utilization of the WeChat friend center. The items were discussed by five graduate students majoring in psychology who were asked to revise the items to enhance brevity and clarity if necessary. Following this, four items were adopted. Then, 100 college students (87 males and 13 females; age range 17–25 years old) completed the questionnaire who were not included in the formal investigation. Exploratory factor analysis (EFA; principal axis factoring (PAF)) and reliability analyses were conducted on the 100 samples. Items with communalities below 0.2 and factor loading below 0.45, as well as components with Eigenvalues below 1, would have been excluded, but this was not necessary. The analyses indicated good validity and reliability for the scale. The total KMO coefficient was 0.707. EFA indicated the expected one-component structure

Table 1 Problematic utilization scale of WeChat friend center

	Items	Choices
1	The time duration I spend on the WeChat friend center is longer than my expectation	0 No 1 Yes
2	I feel depressed, loss, or irritated, when I cannot access to the WeChat friend center because of Internet interruption	0 No 1 Yes
3	I do not succeed, when I tried to control or stop browsing the WeChat friend center	0 No 1 Yes
4	I feel that I can only be satisfied with more time spending on the WeChat friend center	0 No 1 Yes
1	我花费在微信朋友圈上的时间比原先预期的还要长。	0 否 1 是
2	若没有网络不能刷微信朋友圈,我会觉得沮丧、心情低落或是脾气容易暴躁。	0 否 1 是
3	我曾努力过多次想控制或停止刷微信朋友圈,但并没有成功。	0 否 1 是
4	我觉得需要花更多的时间在微信朋友圈才能得到满足。	0 否 1 是

Table 2 Gender differences about the behavior in WeChat friend center in college students

Item	Male (n = 389)		Female (n = 44)		χ^2	p	Total (n = 433)	
	Yes	No	Yes	No			Yes	No
1 I never or seldom use WeChat friend center	81	308	2	42	6.76 ^a	0.009	83	350
2 I enjoy giving the thumbs-up	67	322	7	37	0.048 ^a	0.826	74	359
3 I enjoy giving comments	91	298	15	29	2.447 ^a	0.118	106	327
4 My comments are usually positive	313	76	38	6	0.897 ^a	0.344	351	82
5 My postings are usually positive	295	94	41	3	6.842 ^a	0.009	336	97
6 I often give posting and never or seldom browse	50	339	0	44	4.918 ^b	0.027	50	383
7 I often browse and never or seldom give posting	255	134	21	23	5.435 ^a	0.020	276	157
The topics of my posting are mainly about								
8 Family	84	308	12	32	1.155 ^a	0.283	93	340
9 Life	239	150	34	10	4.253 ^a	0.039	273	160
10 Mood	208	181	30	14	3.456 ^a	0.063	238	195
11 Job	99	290	14	30	0.982 ^a	0.322	113	320
12 Information sharing	81	208	23	21	0.523 ^a	0.469	204	229
13 PUWF	73	316	18	26	11.676 ^a	0.001	91	342

^aPearson chi-squared test. ^bYates' correction chi-squared test

which accounted for 69.47% of the total variance. Cronbach's alpha coefficient was 0.836, which suggested a satisfactory reliability (Wu, 2008). With this one-component structure, the confirmatory factor analysis (CFA) (maximum likelihood estimation) on the other 100 samples (89 males and 11 females; age range 17–24 years old) indicated a satisfactory model fit (CFI = 0.997, NFI = 0.984, IFI = 0.997, RMSEA = 0.045, CMIN/DF = 1.20). Thus, the final scale consisted of the original four items (see Table 1). Based on the cutoff score of relevant literature (Li et al., 2012; Young, 1996), scores below 1 were taken to represent normal utilization of the WeChat friend center, scores of 1 or above ("yes" answer for one or more items) represented PUWF, and scores of 3 or above ("yes" answer for three or more items) represented abusive utilization of the WeChat friend center.

Measures

Demographic characteristics were collected, including gender and age. Basic information about the utilization of the WeChat friend center was collected using 12 questions (Table 2), which included items on the tendency using the WeChat friend center, positive interactions (giving the thumbs-up or giving comments), positive expressions (positive comments or positive posting), and posting topics (about family, life, mood, job, or information sharing). The newly developed problematic utilization scale of WeChat friend center was used to assess PUWF (see Table 1 for details).

To assess personality, the Sixteen Personality Factor Questionnaire (16PF) was used. The 16PF is a self-report personality test with 188 items with a 3-point response scale (Karson & O'Dell, 1976), e.g., I have capacity to cope with

variety of difficulties. It provides an assessment of general personality factors and can be utilized by psychologists. Higher total scores indicate greater endorsement of such personality trait. The 16PF has been reported to have good reliability (Cattell et al., 1970).

To collect information on life stress, the Adolescent Self-Rating Life Events Checklist (ASLEC) (Liu et al., 1997a; Wang et al., 1999) developed by Liu in 1997 (Liu et al., 1997b) was adopted. It assesses the frequency (with a 2-point response scale: yes or no) and severity (with a 5-point response scale: 5 = “severe influence” and 1 = “no influence”)) of stress over the past 12 months through 27 items, e.g., been misunderstood or mistaken by others. Higher total scores suggest a higher level of life events. The scale has good validity and reliability, with a Cronbach alpha coefficient of 0.85 in this study.

To assess the social support levels, we used the Chinese version of the Social Support Scale (SSS) developed by Xiao (Liu & Shu, 1999; Xiao & Yang, 1987). It is used frequently in the Chinese population (Tan, 2010; Zi et al., 2015) and consists of 10 items reflecting three dimensions: subjective support (four items, e.g., how many close and supportive friends you have during the past 1 year), objective support (three items, e.g., in the past, when you are in emergency, the sources of comfort and care were), and the utility of support (three items, e.g., when you are in trouble, your help mode was). Higher total scores suggest a higher level of social support, with Cronbach’s alpha coefficient of 0.92 in this study.

To assess depression levels, the Patient Health Questionnaire (PHQ-9) was used. It reflects the frequency of depressive symptoms corresponding to the nine diagnostic criteria of major depressive disorder with a 4-point response scale (with 3 = “almost everyday” and 0 = “none”) (Xu et al., 2007), e.g., little interest or pleasure in doing things. Scores 10 or above indicate depression (Levis et al., 2019). Cronbach’s alpha coefficient for Chinese version was ≥ 0.80 (Arrieta et al., 2017).

To assess resilience, the Connor-Davidson Resilience Scale (CD-RISC) was used. This scale consisted of 25 items, with a 5-point response (with 4 = “always” and 0 = “never”), e.g., I have close and safe relationship. The internal reliability of the Chinese version is 0.88, 0.80, and 0.60 for the three factors tenacity, strength, and optimism, respectively (Yu & Zhang, 2007). Higher total scores indicate higher level of resilience.

Procedure

The study was approved by the Human Research Ethics Committee of the Army Medical University and college students were invited to participate verbally and in writing. Those who were willing to take part provided personal written informed consent for students aged 18 or older, or

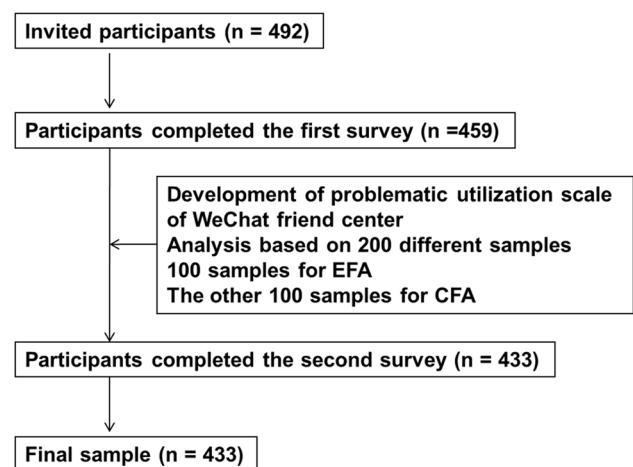


Fig. 1 Flow chart of investigation procedure

informed consent from both students (written) and parents (electronically) for students aged 17. The survey was carried out in a quiet classroom (students sat separately) and lasted for about 30 min. Variables observed in the first year (2017, T1) were personality, depression, life events, social support, and resilience. After, the problematic utilization scale of WeChat friend center was designed. Participants were surveyed again in the second year (2018, T2) with variables of WeChat utilization, depression, life events, social support, and resilience. Students received class credit for their participation after the second year investigation (Fig. 1).

Statistical analyses

Outlier was indicated as higher or lower than mean scores with two standard deviations (Nadine et al., 2012); no outlier was recognized. Pearson’s chi-squared test (Yates’ correction chi-squared test was used for items with subject number less than 5) was carried out to observe the gender differences in the utilization of WeChat friend center. Pearson correlations were conducted to reveal the correlation between the utilization of WeChat friend center and psychosocial variables; Bonferroni’s correction was carried out for multiple correlations ($p < 0.001$). To screen significant data-based predictors, and give more data-based support for hypotheses, a hierarchical linear regression analysis was conducted to examine the impact of demographic variables (age and gender, first layer), long-standing personality (second layer), T1 psychosocial status (third layer), and T2 psychosocial status (fourth layer) on the scores of PUWF, with effect being evaluated according to Cohen’s guidelines (Cohen, 1988). To solve the unbalance between male and female sample, Synthetic Minority Over-Sampling Technique (SMOTE) (Tran et al., 2020) was used to build new balanced dataset (778 in total: 389

males and 389 females); correlation and regression were further analyzed to confirm the gender effect. Structural equation modeling (method: maximum likelihood) was further carried out using AMOS 24.0 to test the potential predictors and mediators (Baron & Kenny, 1986); potential contributors included in the models were the significant predictors in the regression analysis. Evidence of model fit was determined according to standard interpretations of the fit indices, including CFI values of at least 0.950, and an RMSEA no greater than 0.080 (Hu & Bentler, 1999).

Results

Gender differences in the utilization of wechat friend center in college students (Table 2)

A total of 78.98% of students reported normal utilization of the WeChat friend center and 21.02% ($n=91$) reported PUWF (scores ≥ 1), among whom 3.23% ($n=14$) students reported abusive utilization (scores ≥ 3). Overall, students selected more “yes” responses to questions about positive expression and posting topics about life and mood. The χ^2 test showed that females reported more positive posting ($\chi^2=6.842$, $p=0.009$), life topic posting ($\chi^2=4.253$, $p=0.039$), and PUWF ($\chi^2=11.676$, $p=0.001$) than males, and they reported lower ratio of seldom utilization ($\chi^2=6.76$, $p=0.009$), posting without browsing ($\chi^2=4.918$, $p=0.027$), and browsing without posting ($\chi^2=5.435$, $p=0.02$) than males.

Correlation between PUWF scores and psychosocial factors (Table 3)

Pearson correlations between PUWF and psychosocial factors further showed that PUWF was positively correlated with higher depression, more life events, and a higher level of apprehension and tension factor in the 16PF ($r=0.17\sim 0.24$, $p<0.05$), and lower levels of reasoning, emotional stability, and perfection in the 16PF ($r=-0.17\sim -0.23$, $p<0.05$). Surprisingly, social support was poorly correlated with PUWF ($r\approx 0$). Finally, psychosocial variables such as social support, resilience, and warmth, dominance, emotional stability, liveliness, rule-consciousness, perfection, and social boldness in the 16PF were positively correlated ($r=0.17\sim 0.55$, $p<0.05$), but negatively correlated with depression and life events ($r=-0.17\sim -0.37$, $p<0.05$) (Table 3). Synthetic Minority Over-Sampling Technique (SMOTE) was used to balance the gender in the sample; analysis based on the balanced dataset generating from SMOTE showed similar results in correlation (Table S1).

Regression analysis of PUWF scores (Tables 4 and 5)

To identify the predictors of PUWF, demographic variables (age and gender, first layer), personality (second layer), and current psychosocial status (third layer) were included in a hierarchical linear regression. The results (Table 4) indicated that predictor variables accounted for 13.7% of the variance in PUWF ($F=3.982$, standard $R^2=0.137$, $p<0.001$), including female gender, lower perfection and reasoning as measured utilizing 16PF, higher frequency of life events, and higher apprehension and rule-consciousness as measured utilizing 16PF. This qualified as a medium effect according to Cohen’s guidelines (Cohen, 1988). Demographic variables, longstanding personality, and current psychosocial variables accounted for 1.3%, 11.1%, and 1.3% of the variance in PUWF, respectively, with the strongest risk predictor being female gender (in 16PF, the strongest risk predictor was apprehension).

To observe the accumulated prediction of PUWF, demographic variables (age and gender, first layer), personality (second layer), T1 psychosocial status (third layer), and T2 psychosocial status (fourth layer) were included in a hierarchical linear regression. The results (Table 5) indicated that in the accumulated model, predictor variables accounted for 14.1% of the variance in T2 PUWF ($F=3.529$, adjusted $R^2=0.141$, $p<0.001$), including female gender, lower perfection and reasoning as measured utilizing 16PF, higher apprehension, dominance, and rule-consciousness as measured utilizing 16PF, and higher frequency of T2 life events and T1 depression. This qualified as a medium effect according to Cohen’s guidelines (Cohen, 1988). Demographic variables, longstanding personality, and T1 and T2 psychosocial variables accounted for 1.3%, 12.4%, 1.1%, and 0.6% of the variance in PUWF, respectively, with the strongest risk predictor being female gender (in 16PF, the strongest risk predictor was apprehension).

SMOTE was used to balance the gender in the sample; analysis based on the balanced dataset generating from SMOTE showed similar results (with more significant predictors and stronger explaining power) in regression (Table S2 and Table S3).

Prediction of apprehension on PUWF scores and mediation effect (Fig. 2; Fig. 3)

Based on the regression results, a hypothesis-driven structural equation model was tested. Potential constructs between variables were based on the literature. Non-significant pathways were removed from the final model. This showed that at T1, apprehension had direct and indirect effects on T2 PUWF; the model fit was quite good: CFI = 0.981, IFI = 0.982, NFI = 0.954, RMSEA = 0.038, CMIN/DF = 1.633 (Fig. 2) (standardized coefficients

Table 3 Correlation between PUFW scores and psychosocial factors

	PUFW	Age	A	B	C	E	F	G	H	I	L	M	N	O	Q1
\bar{x}	0.33	18.93	9.12	10.89	16.30	12.78	14.92	12.66	11.26	9.92	8.41	13.47	9.87	8.25	11.02
S.D	0.76	1.41	3.66	1.91	3.93	3.54	4.90	3.24	4.70	2.98	2.87	3.44	2.41	3.75	2.63
PUFW	1.00														
Gender	0.12														
Age	0.08	1.00													
A	0.11	0.06	1.00												
B	-0.17*	-0.02	0.00	1.00											
C	-0.17*	0.02	0.06	0.19*	1.00										
E	-0.02	0.10	0.12	0.22*	0.18*	1.00									
F	-0.04	0.03	0.42*	0.18*	0.29*	0.44*	1.00								
G	-0.03	-0.02	0.10	0.24*	0.41*	0.26*	0.21*	1.00							
H	-0.09	0.17*	0.29*	0.17*	0.36*	0.53*	0.60*	0.34*	1.00						
I	0.12	0.06	0.11	-0.06	-0.11	-0.06	0.06	-0.15	-0.06	1.00					
L	0.13	-0.02	-0.09	-0.14	-0.42*	-0.10	-0.26*	-0.23*	-0.27*	0.10	1.00				
M	-0.03	0.10	0.05	0.01	0.07	0.11	0.28*	-0.06	0.17*	0.32*	-0.03	1.00			
N	0.00	-0.05	0.03	0.02	0.04	-0.09	0.04	-0.01	-0.01	-0.02	-0.14	0.07	1.00		
O	0.25*	-0.03	-0.09	-0.27*	-0.48*	-0.36*	-0.42*	-0.33*	-0.44*	0.11	0.43*	-0.19*	-0.06	1.00	
Q1	-0.08	0.00	-0.12	0.12	0.05	0.11	-0.05	0.14	0.05	0.07	-0.03	-0.03	0.07	-0.16	1.00
Q2	-0.03	-0.11	-0.33	-0.01	-0.07	-0.13	-0.35*	-0.08	-0.27*	0.02	0.15	0.01	0.06	0.04	0.20
Q3	-0.23*	-0.01	-0.01	0.20*	0.40*	0.15	0.21*	0.40*	0.22*	-0.06	-0.31*	0.09	0.00	-0.39*	0.12
Q4	0.20*	0.01	-0.12	-0.23*	-0.44*	-0.20*	-0.34*	-0.28*	-0.41*	0.09	0.35*	-0.15	-0.07	0.50*	-0.09
PHQ-9	0.19*	-0.13	-0.11	-0.16	-0.27*	-0.14	-0.22*	-0.09	-0.20*	0.03	0.26*	-0.07	-0.04	0.29*	0.01
ASLECF	0.14	-0.08	-0.05	-0.06	-0.20*	-0.10	-0.16	-0.13	-0.10	0.09	0.20*	-0.05	-0.07	0.30*	-0.02
ASLECQ	0.13	-0.10	-0.06	-0.11	-0.20*	-0.13	-0.11	-0.12	-0.12	0.05	0.20*	-0.09	-0.02	0.30*	-0.05
Resilience	-0.08	0.07	0.15	0.09	0.25*	0.23*	0.30*	0.23*	0.32*	-0.07	-0.16	0.01	-0.03	-0.31*	0.04
SS	0.00	0.02	0.15	0.06	0.18*	0.11	0.25*	0.16	0.21*	0.05	-0.15	0.07	-0.02	-0.18*	-0.01
PHQ-9	0.14	-0.13	-0.14	-0.17*	-0.37*	-0.06	-0.19*	-0.22*	-0.23*	0.09	0.32*	-0.07	-0.05	0.32*	0.04
ASLECF	0.18*	0.01	0.01	-0.12	-0.20*	-0.03	-0.14	-0.09	-0.11	0.07	0.20*	-0.05	-0.08	0.23*	0.02
ASLECQ	0.12	0.00	-0.05	-0.09	-0.25*	-0.01	-0.12	-0.12	-0.12	0.03	0.20*	-0.04	-0.08	0.26*	-0.01
Resilience	-0.13	0.07	0.18*	0.13	0.43*	0.27*	0.40*	0.40*	0.42*	-0.04	-0.23*	0.08	0.00	-0.42*	0.01
SS	-0.02	0.06	0.20*	0.12	0.29*	0.19*	0.33*	0.31*	0.31*	0.04	-0.21*	0.10	0.03	-0.26*	0.04

Table 3 (continued)

	T1										T2									
	Q2	Q3	Q4	PHQ-9	ASLECF	ASLECQ	Resilience	SS	PHQ-9	ASLECF	ASLECQ	Resilience	SS	PHQ-9	ASLECF	ASLECQ	Resilience	SS		
\bar{x}	11.73	13.15	11.27	5.19	8.99	7.21	70.16	36.47	4.20	4.20	6.00	73.21	36.89	4.20	4.20	6.00	73.21	36.89		
S.D	3.59	2.90	3.71	4.02	6.99	6.58	15.48	6.37	4.01	3.32	6.59	14.55	6.70	4.01	3.32	6.59	14.55	6.70		
PUWF																				
Gender																				
Age																				
A																				
B																				
C																				
E																				
F																				
G																				
H																				
I																				
L																				
M																				
N																				
O																				
Q1	1.00																			
Q2	0.02	1.00																		
Q3	0.06	-0.39*	1.00																	
Q4	0.12	-0.17*	0.32*	1.00																
PHQ-9	0.11	-0.20*	0.19*	0.38*	1.00															
ASLECF	0.11	-0.19*	0.22*	0.46*	0.76*	1.00														
ASLECQ	-0.12	0.24*	-0.27*	-0.43*	-0.29*	-0.34*	1.00													
Resilience	-0.16	0.17*	-0.21*	-0.14	-0.12	-0.16	0.34*	1.00												
SS	0.19*	-0.20*	0.39*	0.54*	0.33*	0.39*	-0.36*	-0.06	1.00											
PHQ-9	0.06	-0.19*	0.19*	0.24*	0.46*	0.43*	-0.11	-0.05	0.30*	1.00										
ASLECF	0.12	-0.17*	0.23*	0.30*	0.40*	0.48*	-0.19*	-0.13	0.44*	0.82*	1.00									
ASLECQ	-0.14	0.37*	-0.35*	-0.37*	-0.25*	-0.32*	0.55*	0.25*	-0.50*	-0.29*	-0.38*	1.00								
Resilience	-0.25*	0.22*	-0.31*	-0.24*	-0.19*	-0.18*	0.30*	0.50*	-0.25*	-0.14	-0.23*	0.44*	1.00							
SS																				

*Bonferroni's correction for multiple correlations: $p < 0.001$. T1, year 2017; T2, year 2018; PUWF, problematic utilization of WeChat friend center; SS, social support; A, warmth; B, reasoning; C, emotional stability; E, dominance; F, liveliness; G, rule-consciousness; H, social boldness; I, sensitivity; L, vigilance; M, abstractedness; N, privateness; O, apprehension; Q1, openness to change; Q2, self-reliance; Q3, perfection; Q4, tension; PHQ-9, Patient Health Questionnaire-9; ASLECF, Adolescent Self-Rating Life-events Checklist; F, frequency; Q, quantity

Table 4 Hierarchical linear regression for instant model of PUWF scores

		Model 1				Model 2				Model 3			
		<i>B</i>	Beta	<i>t</i>	<i>p</i>	<i>B</i>	Beta	<i>t</i>	<i>p</i>	<i>B</i>	Beta	<i>t</i>	<i>p</i>
Demographic	Gender M												
	Gender F	0.27	0.11	2.24	0.03	0.33	0.13	2.78	0.01	0.35	0.14	2.96	<0.01
	Age	0.03	0.06	1.33	0.19	0.04	0.07	1.44	0.15	0.04	0.08	1.63	0.10
Longstanding	A					0.02	0.08	1.57	0.12	0.01	0.07	1.34	0.18
	B					−0.05	−0.12	−2.52	0.01	−0.04	−0.11	−2.29	0.02
	C					0.00	−0.02	−0.42	0.67	0.00	−0.02	−0.26	0.79
	E					0.02	0.10	1.83	0.07	0.02	0.10	1.79	0.07
	F					0.01	0.07	1.00	0.32	0.01	0.09	1.33	0.18
	G					0.03	0.14	2.63	0.01	0.03	0.14	2.54	0.01
	H					−0.02	−0.11	−1.61	0.11	−0.02	−0.11	−1.61	0.11
	I					0.02	0.09	1.87	0.06	0.02	0.08	1.55	0.12
	L					0.00	0.00	0.09	0.93	0.00	−0.01	−0.15	0.88
	M					−0.01	−0.05	−0.90	0.37	−0.01	−0.05	−0.87	0.38
	N					0.00	0.01	0.30	0.77	0.00	0.02	0.34	0.74
	O					0.04	0.17	2.78	0.01	0.03	0.17	2.65	0.01
	Q1					−0.01	−0.04	−0.81	0.42	−0.02	−0.06	−1.14	0.25
	Q2					0.01	0.03	0.63	0.53	0.01	0.04	0.83	0.40
	Q3					−0.04	−0.17	−3.09	<0.01	−0.04	−0.15	−2.70	0.01
	Q4					0.01	0.04	0.61	0.54	0.01	0.03	0.51	0.61
T2	PHQ-9									0.01	0.06	1.00	0.32
	ASLEC F									0.05	0.24	2.94	<0.01
	ASLEC Q									−0.02	−0.19	−2.15	0.03
	Resilience									0.00	−0.05	−0.85	0.40
	SS									0.00	0.04	0.73	0.46
<i>R</i> ²		0.018				0.16				0.183			
Standard <i>R</i> ²		0.013				0.124				0.137			
<i>F</i>		3.933				4.387				3.982			
<i>p</i>		0.020				<0.001				<0.001			

T2, year 2018; *SS*, social support; *A*, warmth; *B*, reasoning; *C*, emotional stability; *E*, dominance; *F*, liveliness; *G*, rule-consciousness; *H*, social boldness; *I*, sensitivity; *L*, vigilance; *M*, abstractedness; *N*, privateness; *O*, apprehension; *Q1*, openness to change; *Q2*, self-reliance; *Q3*, perfection; *Q4*, tension; *PHQ-9*, Patient Health Questionnaire-9; *ASLEC*, Adolescent Self-Rating Life-events Checklist; *F*, frequency; *Q*, quantity

between variables were listed). The direct effect of apprehension was 0.223 (87.45% of the total effect 0.255, $p < 0.001$), while the indirect effect through recent life events was 0.032 (12.55% of the total effect 0.255, $p = 0.017$), which indicated a mediation effect of recent life events (Hayes, 2013). Being of female gender also contributed to PUWF (direct effect = 0.143, $p < 0.01$).

Based on the regression result, a hypothesis-driven structural equation model was carried out with variables of apprehension, T1 depression, T2 life events, and gender. Potential constructs between variables were based on the literature. Non-significant pathways were removed from the final model (Fig. 2). The accumulated model for T2 showed that apprehension had direct and indirect effects on T2 PUWF; the model fit was quite good: CFI=0.973, IFI=0.975, NFI=0.953, RMSEA=0.050, CMIN/DF=2.097 (Fig. 3) (standardized coefficients between variables were listed).

The direct effect of apprehension was 0.194 (75.78% of the total effect 0.256, $p < 0.001$), while the indirect effect through T1 depression and T2 life events was 0.062 (24.22% of the total effect 0.256, $p = 0.01$). T1 depression had a direct effect (0.118, $p < 0.05$) on PUWF, while the indirect effect (0.022, $p = 0.045$) through T2 frequency of life events was also significant, which indicated a mediation effect of T1 depression and T2 life events. Again, female gender contributed to PUWF significantly (direct effect=0.152, $p < 0.01$).

Discussion

This is the first study to explore the prediction of personal-ity on PUWF and dynamic mediators longitudinally. In this sample, 21.02% of students reported PUWF. Males utilized

Table 5 Hierarchical linear regression for accumulated model of PUWF scores

	Model 1				Model 2				Model 3				Model 4			
	B	Beta	t	p	B	Beta	t	p	B	Beta	t	p	B	Beta	t	p
Demographic	Gender M	0.27	0.11	2.24	0.03	0.33	0.13	2.78	0.01	0.36	0.14	2.99	0.37	0.15	3.07	<0.01
	Gender F	0.03	0.06	1.33	0.19	0.04	0.07	1.44	0.15	0.05	0.09	1.83	0.05	0.09	1.82	0.07
	Age					0.02	0.08	1.57	0.12	0.02	0.08	1.57	0.01	0.07	1.32	0.19
Longstanding	A					-0.05	-0.12	-2.52	0.01	-0.05	-0.11	-2.36	-0.04	-0.11	-2.19	0.03
	B					0.00	-0.02	-0.42	0.67	0.00	-0.01	-0.17	0.00	-0.01	-0.20	0.84
	C					0.02	0.10	1.83	0.07	0.02	0.11	1.96	0.02	0.11	1.99	0.05
	E					0.01	0.07	1.00	0.32	0.01	0.07	1.02	0.01	0.10	1.39	0.17
	F					0.03	0.14	2.63	0.01	0.03	0.13	2.36	0.03	0.12	2.22	0.03
	G					-0.02	-0.11	-1.61	0.11	-0.02	-0.13	-1.89	-0.02	-0.12	-1.79	0.07
	H					0.02	0.09	1.87	0.06	0.02	0.09	1.79	0.02	0.08	1.62	0.11
	I					0.00	0.00	0.09	0.93	0.00	-0.01	-0.17	0.00	-0.01	-0.27	0.79
	L					-0.01	-0.05	-0.90	0.37	-0.01	-0.05	-0.97	-0.01	-0.05	-0.96	0.34
	M					0.00	0.01	0.30	0.77	0.01	0.02	0.45	0.01	0.02	0.41	0.68
	N					0.04	0.17	2.78	0.01	0.03	0.15	2.42	0.03	0.16	2.51	0.01
	O					-0.01	-0.04	-0.81	0.42	-0.01	-0.05	-0.94	-0.02	-0.06	-1.18	0.24
	Q1					0.01	0.03	0.63	0.53	0.01	0.03	0.50	0.01	0.05	0.86	0.39
	Q2					-0.04	-0.17	-3.09	<0.01	-0.04	-0.17	-3.10	-0.04	-0.15	-2.72	0.01
	Q3					0.01	0.04	0.61	0.54	0.00	0.01	0.22	0.00	0.02	0.34	0.74
	Q4									0.03	0.14	2.46	0.03	0.14	2.43	0.02
T1	PHQ-9									0.01	0.07	0.97	0.33	0.03	0.38	0.70
	ASLEC F									0.00	-0.03	-0.34	0.73	-0.01	-0.18	0.86
	ASLEC Q									0.00	0.03	0.45	0.65	0.03	0.47	0.64
	Resilience									0.01	0.05	0.92	0.36	0.02	0.36	0.72
	SS													0.00	-0.04	0.97
T2	PHQ-9													0.00	-0.04	0.01
	ASLEC F													0.22	2.54	0.01
	ASLEC Q													-0.18	-2.00	0.05
	Resilience													0.00	-0.06	0.41
	SS													0.04	0.67	0.50
R ²		0.018				0.16				0.183			0.197			
Standard R ²		0.013				0.124				0.135			0.141			
F		3.933				4.387				3.929			3.529			
p		0.020				<0.001				<0.001			<0.001			

T1, year 2017; T2, year 2018

Fig. 2 Instant model for PUWF. Notes: *** $p < 0.001$. ** $p < 0.01$. * $p < 0.05$. Pathway coefficients represented standardized coefficients between variables. Key information of model: CFI=0.981, IFI=0.982, NFI=0.954, RMSEA=0.038, CMIN/DF=1.633

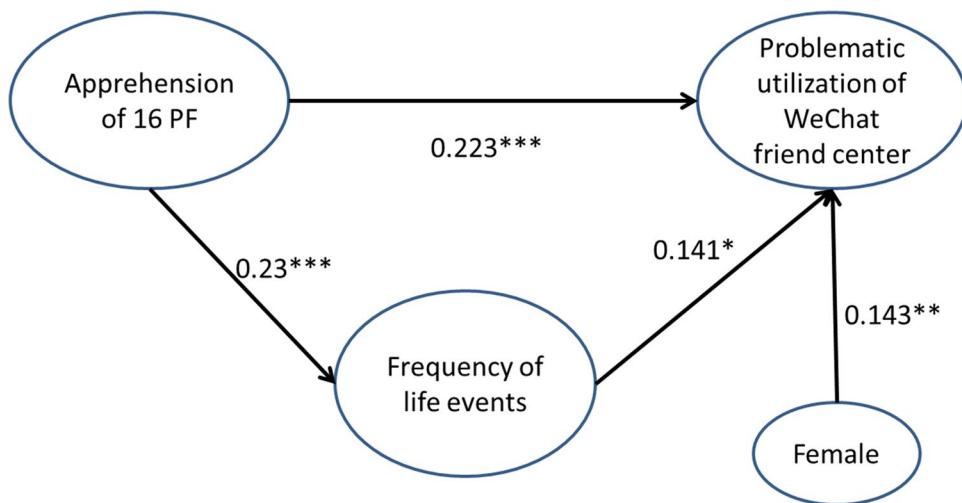
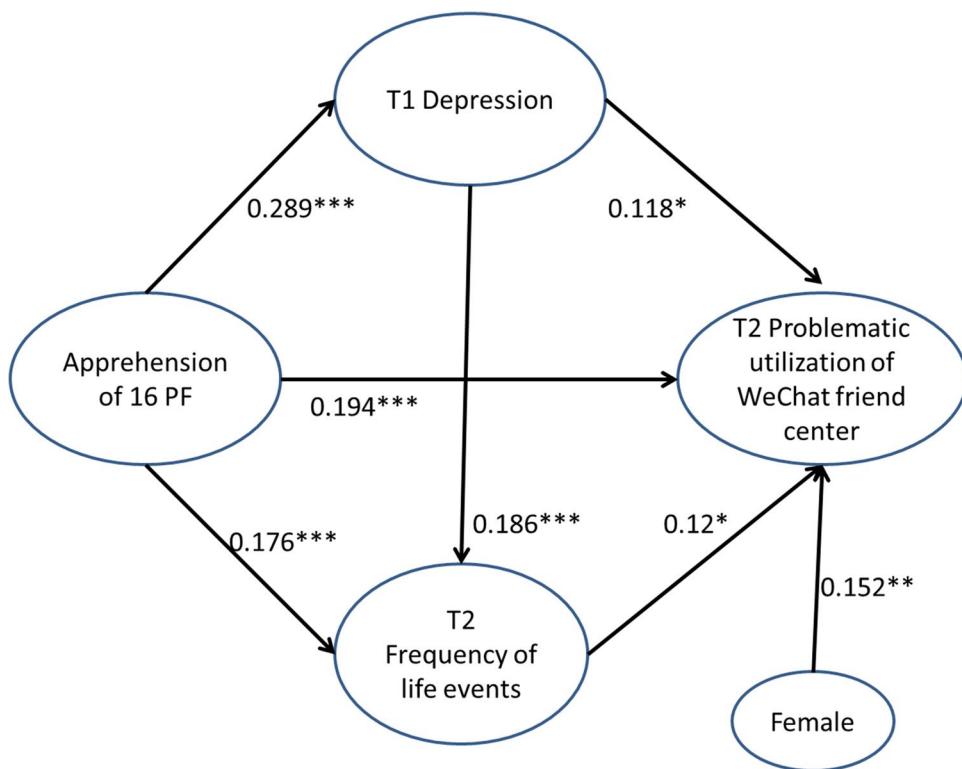


Fig. 3 Accumulated model for PUWF. Notes: *** $p < 0.001$. ** $p < 0.01$. * $p < 0.05$. Pathway coefficients represented standardized coefficients between variables. T1, year 2017; T2, year 2018. Key information of model: CFI=0.973, IFI=0.975, NFI=0.953, RMSEA=0.050, CMIN/DF=2.097



the WeChat friend center less often and females were at higher risk of PUWF. Too much utilization of WeChat friend center was positively correlated with higher depression, more life events, higher level of apprehension and tension, and lower level of emotional stability in the 16PF. Regression analysis showed that reasoning, apprehension, dominance, perfection, and rule-consciousness in the 16PF, and being female, depression, and life events significantly predicted PUWF, and that female gender was the strongest predictor. The testing of the hypothesis-driven model confirmed that apprehension had a direct

effect on T2 PUWF, which was mediated by T1 depression and T2 life events.

Our finding is that 21.02% of students reported problematic utilization and 3.23% reported abusive utilization of the WeChat friend center, which is comparable to previous reports of problematic use of the Internet (24.74%) (Meena et al., 2012) and Internet abuse (1.6–4.9%) (Munno et al., 2017; Yang et al., 2005). The results suggest that college students report equal ratio of PUWF compared with problematic use of Internet in other population;

i.e., their utilization on SNS was problematic, which needs more attention in the future study.

Pearson correlations found that too much utilization of the WeChat friend center was related to suboptimal mental health, which is similar to previous reports about WeChat (Pang, 2018; Wen et al., 2016). Regression analysis showed that reasoning, apprehension, dominance, perfection, and rule-consciousness in the 16PF, and being female, depression, and life events predicted PUWF, and that female gender was the strongest predictor. The hypothesis-driven model testing confirmed that apprehension personality had a direct effect on T2 PUWF, which was also mediated by T1 depression and T2 life events. The results suggested that apprehension personality increased the PUWF, which was partially but significantly mediated by life events and depression.

For the first time, this study provides support for the Uses and Gratifications approach (Katz et al., 1974) relating to the psychosocial predictors of PUWF. That is to say, females with higher levels of apprehension are at higher risk of PUWF if they experience more negative life events or depression over the past 12 months. In other words, females and individuals who experienced previous depression and life events should be considered to be at higher risk for PUMF, and enhancement of psychological diathesis might be the most effective way to overcome this risk given that apprehension personality was a strong risk predictor of PUWF at both time points. For social media, most users utilize it for social purpose (Wang et al., 2018); friend center is a social part of social media—WeChat; thus, it might be assumed that more users use it for social purpose compared with other purpose such as gaming or entertainment. However, we did not confirm the motivation of students in their utilization of WeChat friend center directly; we thus could not confirm the motivation of students as social purpose for 100%. Therefore, although apprehension trait might be viewed as being the basis for the implicit personality needs which put individuals at higher risk for PUWF, without confirmation of explicit motivation for PUWF, this study was not a traditional Uses and Gratifications design. Thus, it would be worthwhile to confirm the motivations underlying utilization of the WeChat friend center directly in the future studies. However, the current longitudinal design allowed us to identify implicit personality basis and potential mediators for PUWF and then to better prevent it through paying more attention to these vulnerable factors.

Hypothesis 1

Personality variables, especially that of neuroticism, have often been reported as being involved in Internet problematic utilization in the literature (Hou et al., 2018; Zhou et al.,

2018). However, in this study, we found that apprehension trait consistently emerged as an important personality predictor of PUWF in instant model and longitudinal accumulated model. The possible reason for this might be that, compared with general Internet use, the friend center of SNS provides a different experience by more focusing on interpersonal interactions between friends, and is optional, with fewer obligations and restrictions. Indeed, apprehension and worry are more closely correlated with social interaction (Pang, 2018; Zhang et al., 2011) than neuroticism or emotional instability, which are more closely related to online behaviors such as gambling, gaming, or searching for information (Hou et al., 2018; Zhou et al., 2018). Thus, in this study, apprehension consistently predicts PUWF, and this personality basis could be considered in the prevention of PUWF.

Hypothesis 2

Our results showed that T1 depression predicted T2 PUWF significantly but T2 depression did not, although we had predicted that both current and previous depression would predict PUWF. It appears that emotional status had delayed and prolonged impact on online behavior. In other words, as a behavioral habit, PUWF was developed and formed by more stable and prolonged factors (in this case, depression in the previous year) rather than short-term or occasional factors (i.e., current depression). Conversely, problematic Internet use might contribute to current depression (Tamura et al., 2017). Thus, to reduce current PUWF effectively, depression level in the previous year should be considered, while to prevent later PUWF, current psychosocial levels should be considered. Referring to the COVID-19 pandemic, it led to 28.3% anxiety and 30.8% depression in Chinese young people (Ren et al., 2021), which might increase later PUWF significantly and need attention.

Hypothesis 3

Interestingly, both the frequency and the quantity of life events increased the PUWF. That is to say, either the accumulative effect of life events or the frequency of life events increased the use of the friend center on WeChat, in which the frequency of life events had stronger effect. The negative life events which occurred over the past 12 months were influential for PUWF, and further confirmed the chronic development of PUWF in young adults instead of occasional behavior. Thus, to prevent PUWF, intervention regarding the experience of accumulated major life events should be considered. Referring to the COVID-19 pandemic, although the longitudinal impact of the pandemic decreased in Chinese (C. Wang et al., 2020), the accumulated impact of the pandemic might increase later PUWF and need further attention.

Surprisingly, resilience (Yen et al., 2019) and social support (Hou et al., 2018; Pang, 2018) were found to be closely correlated with Internet use but were not predictors of PUWF. In other words, levels of resilience or social support do not causally predict PUWF in the current study. The potential reason for this might be that the influence of resilience and social support on the utilization of the WeChat friend center has been covered by other psychosocial variables, such as apprehension, depression, and life events, which had a more overwhelming influence on PUWF. Thus, referring to the risk and resilience framework of PUWF (Cains & Henshel, 2021; Kiss & Piko, 2019), only risk predictors for PUWF were confirmed in the current study.

Hypothesis 4

Our findings also suggested a gender difference in the utilization of the friend center on WeChat. More specifically, males used the WeChat friend center less than females, and females reported more PUWF than males; female gender was the strongest risk predictor of PUWF, which was different from Hypothesis 4. It has been well documented that males are more prone to Internet problematic utilization than females (Choi et al., 2015; Munno et al., 2017), which is different with our findings. The reason might be that, in previous studies, general Internet use was targeted, e.g., gambling, gaming, or searching for information, most of which are independent and belonging to individual online behaviors not necessarily connecting with others, and preferred by males. However, the friend center is an optional social interaction platform in online SNS—WeChat, with fewer obligations and more flexibility which is preferred by females, who are in general more sociable and more willing to communicate with others in some way (Seltmann et al., 2019). Thus, females are at higher risk of PUWF than males. This first observation of female vulnerability to PUWF in college students adds to the understanding of gender preference in Internet use; i.e., different genders prefer different kinds of Internet functions. This knowledge should also be considered in the prevention of PUWF.

Limitations

In consideration of the limitations of this study, it should be noted first that the sample of this study was relatively small ($n = 433$), which may limit the explanatory power of our findings. Second, the gender ratio in this study was not balanced; although the SMOTE method was used to balance the female gender, we should still be very cautious to generate the results to the general population. Third, some important variables such as coping style and other psychological statuses (alcohol abuse, anxiety (Ho et al., 2014), sleep quality (Zhang et al., 2017), quality of life

(Zhang et al., 2017), etc.) were not included in this study, which might be potential predictors or outcomes of PUWF. Fourth, although this study was based on the Use and Gratifications approach, we did not observe explicit motivation over implicit personality need directly; thus, this study was not a traditional Use and Gratifications design. However, with the current longitudinal design, it allows an observation of longitudinal prediction of personality on later PUWF and dynamic mediators.

Conclusion

In conclusion, the current study is the first to explore the predictions of personality on PUWF and potential mediators longitudinally. In this sample, 21.02% of students reported problematic utilization. The finding that females reported too much utilization of the WeChat friend center suggests a gender effect in PUWF, which correlates with worse mental health. Apprehension personality predicts PUWF directly, which is mediated by previous depression and life events over the past 12 months. The findings imply suggestions for the functional design of SNS according to the users; i.e., different genders prefer different functions. The findings are that direct and indirect effect of apprehension on PUWF through depression and life events further helps to identify populations at risk of PUWF and seeks approaches toward better prevention and treatment.

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Data availability The datasets generated and analyzed during the current study are available online.

Declarations

Conflict of interest The authors declare no competing interests.

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