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Published Version

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Kuang, Jin, Arnett, Jeffrey Jensen, Chen, Erle, Demetrovics, Zsolt, Herold, Fabian, Cheung, Rebecca Y. M. ORCID logo ORCID: <https://orcid.org/0000-0003-0998-7991>, Hall, Daniel L., Markwart, Michaela, Gerber, Markus, Ludyga, Sebastian, Kramer, Arthur F. and Zou, Liye (2023) The relationship between dimensions of emerging adulthood problems among Chinese emerging adults: the mediating role of physical activity and self-control. *International Journal of Mental Health Promotion*, 25 (8). pp. 937-948. ISSN 2049-8543 doi: <https://doi.org/10.32604/ijmhp.2023.029187> Available at <https://centaur.reading.ac.uk/110687/>

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Identification Number/DOI: <https://doi.org/10.32604/ijmhp.2023.029187>
<<https://doi.org/10.32604/ijmhp.2023.029187>>

Publisher: Tech Science Press

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ARTICLE

The Relationship between Dimensions of Emerging Adulthood and Behavioral Problems Among Chinese Emerging Adults: the Mediating Role of Physical Activity and Self-Control

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Received: 02 January 2023; Accepted: 06 February 2023

ABSTRACT

Emerging adulthood (EA) is a critical stage of life to develop and sustain a healthy lifestyle, which is also a time of vulnerability to poor physical and mental health outcomes. In this study, we conducted a path analysis ($N = 1326$) to examine associations among four dimensions of EA, levels of regular physical activity (PA), self-control, MPA tendency and irrational procrastination. Results found: 1) higher levels of PA predicted both MPA tendency ($\beta = -0.08$, 95% CI: -0.11 to -0.06 , $p < 0.001$) and irrational procrastination ($\beta = -0.01$, 95% CI: -0.17 to -0.008 , $p < 0.01$) indirectly via self-control; 2) Instability ($\beta = 0.13$, 95% CI: 0.08 to 0.18 , $p < 0.01$) and Responsibility ($\beta = -0.06$, 95% CI: -0.10 to -0.08 , $p = 0.03$) exerted direct effects on irrational procrastination and Instability also indirectly predicted irrational procrastination via MPA tendency ($\beta = 0.03$, 95% CI: 0.02 to 0.05 , $p < 0.01$). These findings proved that perceived features of EA are linked to behavioral problems and supported that regular PA plays a crucial role to protect mental health.

KEYWORDS

Emerging adulthood, Chinese culture, Physical activity, Mobile phone addiction, Irrational procrastination, Self-control



Introduction

The concept of emerging adulthood characterizes a specific life stage between adolescence and adulthood, especially in industrialized societies, that ranges from approximately 18 to 29 years [1–4]. The unique phenomenon of emerging adulthood has been confirmed in a wide range of different cultures such as in America [5], in Asia [6–8], and in Europe [9]. Emerging adulthood is characterized by five prominent features: Identity explorations, instability, self-focus, perception of being in-between adolescence and adulthood, and optimism/possibilities [2]. Firstly, as a period of identity exploration, emerging adulthood is perceived to have a state of a psychosocial moratorium to form a mature identity, when extensive exploration tends to occur with scarce commitment [10,11]. Secondly, it is a period of instability, as emerging adults make frequent changes in their jobs, social relationships, and places of residence [1]. Thirdly, it is a period of self-focus when emerging adults enjoy a higher level of autonomy than adolescents to focus on personal development [11,12]. Fourthly, emerging adulthood is also the period of feeling in-between as most emerging adults no longer perceive themselves as adolescents but not yet fully adults [1]. Finally, emerging adulthood tends to be a period of optimism, as there is a widespread sense of a broad range of possible jobs, places to live, and potential romantic partners [13].

As a transitional period, emerging adulthood is a critical stage in the life course of an individual in terms of developing and manifesting healthy lifestyle behaviors [14]. According to Arnett et al. [14], the five distinctive features of emerging adulthood can influence measures of mental health. In particular, emerging adults who struggle with identity exploration are more likely to report more internalizing problems [15] and problematic behaviors (e.g., substance use; [16]), and increasing health-risk behavior and aggression [17]. Moreover, the more pronounced self-focus is within emerging adults, this may induce a lack of social support along with greater depressive symptoms [18]. The latter (i.e., anxiety and depression), may be reinforced by the in-between feelings and instabilities which occur more frequently in emerging adulthood [19]. In contrast, the feeling of optimism and possibilities in emerging adulthood can positively contribute to the psychological functioning including higher self-esteem and lower social anxiety [20].

In China, a recent study revealed that emerging adults are characterized by four distinct features, namely Self-exploration, Instability, Possibilities and Responsibility [7]. Among these four features, Self-exploration can be perceived as a combination of Identity Exploration and Self-focus, which refers to emerging adults' practice of trying out a variety of opportunities in the areas of romantic relationships, work, and ideology, with the purpose of developing or understanding the things needed for adult life [12]. Responsibility is a unique feature manifested in Chinese culture, which has roots in collectivistic and Confucius values [7]. It is involved with self-sufficiency and other-focused values (e.g., commitments to others, and responsibility for others). Instability and Responsibility are

positively correlated with depression, stress and anxiety, whereas Self-exploration and Possibilities are negatively correlated with these negative emotions [7]. However, research on the relationships between internalizing problems (e.g., anxiety and depression) and features of emerging adulthood is still relatively limited in the Chinese cultural context. Given that emerging adulthood is a critical life stage to influence the health trajectories of an individual, further investigations in this direction are of great practical and theoretical relevance and thus are urgently needed.

Mobile phone use among emerging adults

From the 1980s to the present, the position of the mobile phone in China has experienced a huge change from a luxury item to a popular mass-produced article [21]. Contemporary technological advances have equipped mobile phones with more capabilities and services to provide a wide range of features (e.g., to communicate via telephone, to surf the internet, to track people's health via apps). According to the latest data from the 47th China Statistical Report on Internet development [22], by the end of 2020, emerging adults aged 20 to 29 years account for 20.5% of Chinese mobile internet users and the number of Chinese mobile internet users hit 986 million, of whom 99.7% access the internet via mobile phones. As one of the most omnipresent mobile devices, mobile phones have brought increased convenience to people's daily life. However, the overuse (i.e., problematic use [23]) of mobile phones can lead to negative health consequences. For example, using a mobile phone during driving increases the risk of accidents [24], excessive expenses to get the latest mobile phones elevate the risk of financial problems [25], and higher levels of most importantly mobile phone addiction (MPA). MPA is a behavioral addiction to the mobile phone that refers to the uncontrolled, inappropriate, or excessive dependency on one's mobile phone [26,27]. MPA is closely associated with negative health outcomes such as depression [28], stress [29], and anxiety [30]. Excessive phone use at bedtime can significantly contribute to poor sleep quality [28,31,32] and insufficient sleep duration [33,34]. Based on the above-presented evidence, MPA is a growing and serious problem, especially in emerging adults, that can negatively influence both the mental and physical health of an individual [35,36].

Phone addiction and procrastination

Procrastination is a ubiquitous phenomenon since at least the times of Marcus Cicero in 44 BC [37]. In China, there is a famous poem "Song of tomorrow" [38] from the Ming Dynasty about five hundred years ago saying, "Tomorrow and tomorrow again, how many tomorrows then. If we wait always for another day, in vain our life will pass away...", which describes the phenomenon of procrastination and its negative effects on personal achievements. Procrastination is defined as "to voluntarily delay an intended course of action despite expecting to be worse off for the delay" [39] and is involved in many aspects of life, e.g., bedtime procrastination [40] and academic procrastination [41], throughout the lifespan [42–45] and across cultures [46]. The phenomenon of procrastination is prevalent among emerging adults. In particular, previous studies [e.g., 47]

indicated that the prevalence of procrastination among college students was estimated to be more than 50%. More specifically, Özer [48] found that undergraduate students reported higher levels of procrastination than high school students and graduates.

In a traditional sense [49], procrastination is perceived as “irrational delay” [e.g., 50,51], which results from a failure of self-regulation [39]. However, several studies also observed the phenomenon of “active procrastination”, referring to intentionally procrastinating behaviors that may exert positive effects on attitudes and performance [49]. However, in this study, we investigated negative procrastination behaviors (*i.e.*, irrational procrastination behaviors). Compared to the concept of procrastination, irrational procrastination emphasized the “irrational” delay and “irrationality” referring to the voluntary delay, in spite of expecting it to be harmful [50]. Notably, several studies found evidence that emerging adults who are addicted to mobile phone use can develop irrational procrastination behavior [52,53]. Irrational procrastination not only leads to internal suffering but also could cause external negative consequences [54]. Moreover, irrational procrastination is related to many aspects of well-being, such as increased symptoms of depression and anxiety [55], low satisfaction with life [42,56], and poor health behaviors [57,58]. In summary, excessive irrational procrastination is a serious problem that is relatively prevalent among emerging adults. To understand the phenomena of irrational procrastination in terms of potential determinators, mediators, and consequences, further research is necessary.

Self-control as a mediator

There is growing evidence that self-control is an effective predictor of both mobile phone addiction [e.g., 59,60] and procrastination [e.g., 61,62]. For instance, Khang et al. [63] studied the relationships between self-esteem, self-efficacy, self-control, and mobile phone addiction in a sample of 386 college students. The most significant predictor of all dimensions of MPA was self-control. Geng et al. [64] reported that mobile phone addiction was positively correlated with severity of depression and anxiety among Chinese university students through bedtime procrastination, while the mediated relationships were weak for students with high self-control. Self-control generally refers to the mental capacity to regulate one’s emotions, thoughts, and behaviors by oneself despite conflicting temptations and impulses [65,66], which is of considerable significance for humans to achieve desirable and long-term goals and to inhibit undesirable behavioral responses [67,68]. Self-control has been interpreted at both the state and trait levels [69]. Compared to state self-control that which varies across situations and time, trait self-control has greater stability across situations and over time [70]. A person with good trait self-control is more likely to achieve higher levels of academic performance [71], well-being [72], interpersonal success [69], and has less impulse control problems, such as disinhibited eating behavior [73], mobile phone addiction [74], and procrastination [75].

The impact of physical activity on MPA and procrastination

Regular physical activity, typically engendered through structured forms of physical activity such as physical exercises, exerts beneficial effects on both mental and physical health, while lack of physical activity (*e.g.*, sedentary behavior) could increase the risk of adverse health outcomes such as cardiovascular-related and cancer-related mortality [76,77]. Accumulating evidence supports that both acute and chronic bouts of physical exercise are beneficial for strengthening self-control in children [78], adolescents [79], emerging adults [80], middle-aged adults [81], and older adults [82]. In addition, existing studies [e.g., 74,83,84] provide evidence that higher levels of regular physical activity (PA) is negatively associated with MPA. The negative relationship between PA and MPA indicated that physical exercise interventions could be an alternative or complementary approach to treat MPA [e.g., 85,86]. For instance, Fan et al. [85] examined the effect of 30 h of acute aerobic exercise in college students with MPA and noticed positive effects on inhibitory control. In addition, physical exercise interventions have been used as an effective treatment not only for smartphone addiction [87], but also for procrastination [88]. Besides, several cross-sectional studies [52,89,90] have been conducted to investigate the underlying mechanisms of how PA is related to procrastination in Chinese emerging adults. It is worthwhile to note that self-control mediates the relationship between PA and academic procrastination [90] and thus is an important variable that should be considered in future studies in this research direction.

The current study

The primary aim of the present study was to investigate the underlying psychological mechanisms of how physical activity influences both MPA tendency and procrastination and whether self-control mediates these relationships. The secondary aim was to investigate the underlying psychological mechanisms from the perspective of developmental psychology. Specifically, we sought to clarify how features of emerging adulthood are linked to behavioral problems (*i.e.*, mobile phone addiction and irrational procrastination) in a large sample of Chinese emerging adults. Thus, our study tested three hypotheses: 1) MPA tendency exerts a significant and positive effect on irrational procrastination; 2) PA level has a significant and negative effect on both MPA tendency and irrational procrastination, while trait self-control is a mediator of both the relationship between PA level and MPA tendency and the relationship between PA level and irrational procrastination; 3) all four dimensions of emerging adulthood influence MPA tendency and irrational procrastination to varying extent. The full conceptual model is illustrated in Fig. 1.

Methods

Participants and procedure

From August 10, 2022 to September 24, 2022, convenience sampling via online questionnaires were distributed to

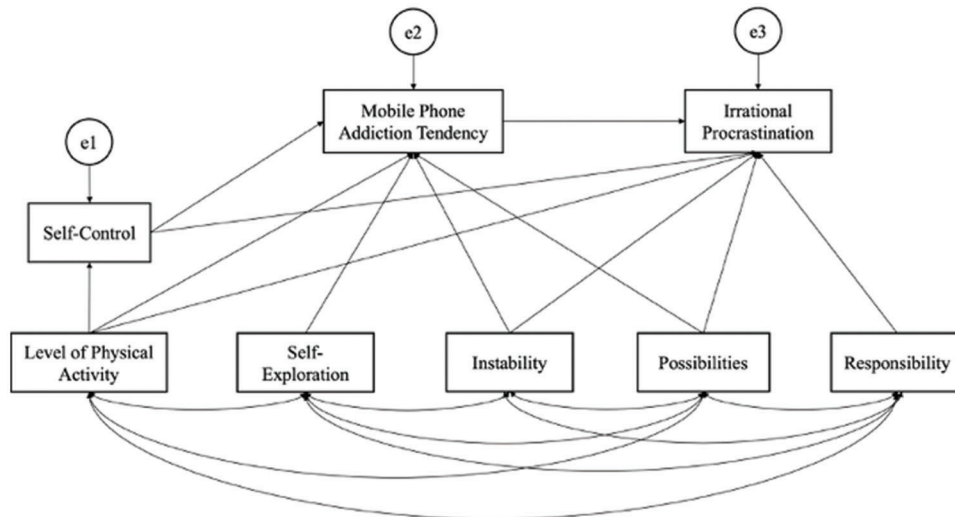


FIGURE 1. The hypothesized structural equation model.

college students across China. The questionnaire was advertised by Questionnaire Star, an online survey platform that used a snowball technique. A total of 1326 college students voluntarily participated in this study, with an average age of 19.99 ± 1.75 years. The study procedures are in accordance with the latest version of the Declaration of Helsinki and ethical approval for the study procedures was obtained from the Ethics Committee of University (NO.PN-2021-048).

Measures

Our online survey included demographic questions concerning age, gender, weight, and height and five other self-report scales that will be described in more detail in the following. The Chinese version of the Inventory of Dimensions of Emerging Adulthood (IDEA-C) was used to assess identification with five features of emerging adulthood [7]. The original version of IDEA was developed by Reifman et al. [91], which comprised 20 items with five factors, including Identity Exploration, Instability, Self-focused, Feeling in-between, and Possibilities. Compared to the original version, the IDEA-C was downsized into a 20-item scale with four factors that are Self-exploration, Instability, Possibilities, Responsibility. All subscales have reasonable internal consistency with Cronbach's alpha coefficients ranging from 0.77 to 0.93. The IDEA-C items were administered with a four-point Likert scale (1 = "totally disagree" to 4 = "totally agree"). In scoring, higher scores in one subscale reflected participants' higher agreement for experience of that feature.

The Chinese version of the short form of the International Physical Activity Questionnaire (IPAQ-C; [92]) assessed the self-reported PA level in the last 7 days. The participants were asked to report the frequency and duration of their PA patterns, including the types of the activity (*i.e.*, walking, vigorous or moderate) and time spent sitting over the preceding seven days. Each type of PA was given certain values of metabolic equivalents of tasks (METs): Walking = 3.3 METs, Moderate PA = 4.0 METs

and Vigorous PA = 8.0 METs. The participants' total PA in a week was computed as a sum of walking, moderate and vigorous METs per week. In this study, total MET-hours/week equals a sum of $3.3 * \text{walking hours} * \text{walking days}$, $4.0 * \text{moderate-intensity activity hours} * \text{moderate days}$ and $8.0 * \text{vigorous-intensity activity hours} * \text{vigorous-intensity days}$ [93].

The Chinese version of the Brief Self-Control Scale (the BSCS-C; [94]) was used in this study as a measurement of trait self-control among our sample of Chinese emerging adults. The 8-item BSCS-C was translated and adapted from the 13-item BSCS [95], which was extracted from the original version of the 36-item SCS [69]. Among eight items, Items 2, 3, 6, 7, and 8 are reversely coded. Higher sum scores reflect greater self-control. Maloney's two-dimensional BSCS model had been confirmed in a Chinese sample by Liang et al. [94] with a range of Cronbach's alpha values from 0.55 to 0.71.

The Chinese version of the Mobile Phone Addiction Tendency Scale (MPATS-C) was used to measure participants' tendency to mobile phone addiction [96]. The 16-item MPAS-C is scored on a five-point scale from 1 = "Not true of me" to 5 = "Totally true of me". Higher sum scores indicate a greater level of mobile phone addiction, with a total score ranging between 16 to 80. The MPATS-C exhibited four subscales, including Withdrawal Symptoms, Salient Behaviors, Social Soothing, and Mood Changes, with Cronbach's α 's 0.55 to 0.80.

The Chinese version of the Irrational Procrastination Scale (the IPS-C) was used to assess participants' level of irrational procrastination [97], which was adapted from the Steel's Irrational Procrastination Scale [50]. The 9-item IPS-C was rated on a 5-point Likert scale, ranging from 1 "Very seldom/Not true of me" to 5 "Very often true/totally true of me", with higher scores reflecting a greater level of irrational procrastination. Among nine items, items 2, 6, and 9 were reversely coded. The unidimensional IPS-C had a good internal consistency reliability (Cronbach's $\alpha = 0.91$) among mainland Chinese college students.

Statistical analysis

Data screening

No missing data was detected. In addition, there was no evidence of multicollinearity in our data set. In other words, correlations between variables were modest and all multiple correlations were below the 0.85 cutoff recommended by Kline [98]. The test of normality was carried out in AMOS v26 via the calculation of Mardia's coefficient. If Mardia's coefficient is significant, (*i.e.*, the critical ratio is greater than 1.96 in magnitude), it reflects a departure from normality [99]. However, in large-sample procedures, such as SEM, this significance test is more likely to produce significant (non-normal) results [100]. Considering the latter reason, it is recommended to consider both the significance tests descriptive statistics, namely the kurtosis values for individual variables, to assess normal distribution [101]. In this context, multivariate kurtosis values greater than 5.00 are an indicator of the absence of multivariate normality [99,102]. In this study, all variables exhibited significant skewness or kurtosis (the critical ratios are greater than 1.96) and multivariate kurtosis values of 20.82 which is greater than the cutoff of 5.00. Given that our data (1) was not normally distributed, and (2) that the distribution maximum likelihood (ML) estimation method is inappropriate in such a case as it leads to a bias in chi-square values, fit indices and standard errors [99], we used the Bollen–Stine bootstrap estimation technique to examine model fit [103], although Hair [104] argued that a big sample size (over 200) can reduce adverse effects of non-normality to a negligible level.

Testing the path analysis model

Descriptive and correlational (Pearson) analyses were performed on SPSS version 26 to examine the sample distribution, means, standard deviations, and associations between all variables included in the model. Using the Bollen–Stine bootstrap estimation, the hypothesized model is estimated via the structural equation modeling (SEM) program (IBM SPSS Amos version 26.0). This method

allows for estimates of hypothesized relationships and provides global indices of the fit between the theoretical model and data. The following variables were included in the model: Level of Physical Activity, Self-exploration, Instability, Possibilities, Responsibility, Self-control, Mobile Phone Addiction Tendency, Irrational Procrastination. Model fit with path analysis was tested by examining the following indices (Kline, 2015): 1) Model chi-square with its degrees of freedom and p-value: $p > 0.05$ = good model fit (although often significant with large samples) and there were no clear-cut guidelines about maximum values of the normed chi-square; 2) Root Mean Square Error of Approximation (RMSEA) and its 90% confidence interval: $RMSEA \leq 0.05$ = good fit, ≥ 0.10 = poor fit; 3) the Comparative Fit Index (CFI) = 1 indicates the best result, ≥ 0.95 = good fit, 0.90 to 0.95 = reasonable fit; 4) the Standardized Root Mean Residual (SRMR) > 0.10 = poor fit.

Assessing direct, indirect and total effects

Bootstrap 95% confidence intervals computing 10,000 samples [105] were used to examine the indirect effects of self-control and MBA tendency between dimensions of emerging adulthood and irrational procrastination and the indirect effects of self-control and MBA tendency between PA level and procrastination. We tested for both the magnitude and significance of direct effects (*e.g.*, path coefficients from PA level to irrational procrastination) and indirect effects (*e.g.*, the product of the path coefficients from PA level to self-control, from self-control to MBA tendency, and from MBA tendency to irrational procrastination).

Results

Correlations, descriptive statistics, and reliabilities

The descriptive statistics of participants were shown in Table 1. The mean and standard deviations for the variables used in the study and the Cronbach's alpha coefficient of all measures are shown in Table 2. Table 3 presents the

TABLE 1

Participants' demographic characteristics and physical health factors ($N = 1326$)

	Total	Men (n = 885) <i>M</i> ± <i>SD</i>	Women (n = 441)	<i>p</i> -value
Age (years)	19.99 ± 1.75	19.90 ± 1.78	20.04 ± 1.73	0.19
Height (cm)	167.48 ± 8.57	176.38 ± 6.38	163.05 ± 5.55	<0.001
Weight (kg)	59.04 ± 11.81	68.99 ± 11.36	54.08 ± 8.41	<0.001
BMI (kg/m ²)	20.92 ± 3.01	22.12 ± 3.07	20.32 ± 2.79	<0.001
Physical activity (MET-hours/week)	45.17 ± 33.23	56.23 ± 34.28	39.66 ± 31.28	<0.001
Low PA	11.5	5.4	14.4	
Moderate PA	50.1	39.7	55.4	
High PA	38.4	54.9	30.2	

Notes: *M* = mean; *SD* = standard deviation; BMI = body mass index; MPA = moderate-intensity physical activity; MET = metabolic equivalent; PA = physical activity.

TABLE 2

Descriptive findings and Cronbach's alpha values for measures ($N = 1326$)

	<i>M</i>	<i>SD</i>	Cronbach's alpha
Level of physical activity	45.2	33.2	
Self-exploration	26.3	3.6	0.92
Instability	15.2	2.6	0.84
Possibilities	10.0	1.5	0.85
Responsibility	10.6	2.2	0.74
Self-control	24.2	3.8	0.64
Mobile phone addiction tendency	45.1	12.1	0.93
Irrational procrastination	27.2	5.0	0.76

Note: *M* = mean; *SD* = standard deviation.

bivariate, zero-order Pearson's correlation coefficients between all the study variables.

Testing of the hypothesized model

The model was found to have a significant Chi-Square goodness of fit test, $\chi^2(7) = 174.5$, Bollen-Stine $p < 0.001$, indicating unacceptable overall fit, which is often the case in large samples [98] and thus it is not recommended to assess the fit of large models [106]. Model fit indices were reported as: RMSEA [90% confidence intervals] = 0.13 [0.12, 0.15]; CFI = 0.93; SRMR = 0.06. The standardized values of the regression coefficients were shown in Fig. 2.

Assessing direct, indirect and total effects

For all tested pathways, standardized direct, specific indirect, total indirect and total effects were estimated (see Table 4). As Table 4 shows, MBA tendency had a positive and significant effect on irrational procrastination ($\beta = 0.24$, 95% CI: -0.18 to -0.29 , $p < 0.01$), thus leading to the conclusion that the first hypothesis was confirmed. Moreover, the bootstrapping method yielded a negative and significant indirect effect of PA level on irrational procrastination both through self-control ($\beta = -0.01$, 95% CI: -0.17 to -0.008 , $p < 0.01$) and through self-control and MBA tendency ($\beta = -0.03$, 95% CI: -0.004 to -0.002 , $p < 0.01$). A similar

indirect effect was observed from PA level on MBA tendency through self-control ($\beta = -0.08$, 95% CI: -0.11 to -0.06 , $p < 0.001$). In this way, the second hypothesis was also confirmed, in that PA level had a negative effect on both MBA tendency and irrational procrastination via self-control. Furthermore, Instability had a positive and significant direct effect on both MBA tendency ($\beta = 0.14$, 95% CI: 0.08 to 0.20, $p < 0.01$) and irrational procrastination ($\beta = 0.13$, 95% CI: 0.08 to 0.18, $p < 0.01$). In addition, the indirect effect of Instability on irrational procrastination via MBA tendency ($\beta = 0.03$, 95% CI: 0.02 to 0.05, $p < 0.01$) was significant. Besides, Responsibility exerted a negative and significant effect on irrational procrastination ($\beta = -0.06$, 95% CI: -0.10 to -0.08 , $p = 0.03$). However, neither Self-exploration nor Possibilities had a significant direct effect on MBA tendency or irrational procrastination. Therefore, the third hypothesis was partially supported as only Responsibility and Instability had significant effects on the two of behavioral problems in the current study.

Discussion

The current study investigated the relationships between the perceived features of emerging adulthood (as captured by the IDEA) and specific behavioral problems (*i.e.*, mobile phone addiction and irrational procrastination) that are prevalent among emerging adults. Moreover, the current study seeks to reveal the influence of the level of regular PA on these behavioral problems using self-control as a mediator. Our findings provide partial support for our initial hypotheses: (1) higher levels of MPA tendency are positively linked to irrational procrastination; (2) higher levels of regular PA had negative indirect and direct effects on irrational procrastination, and the indirect path was mediated through self-control and mobile phone addiction tendency, while higher levels of regular PA were associated with a lower MPA tendency indirectly, via the mediating role of greater self-control; (3) we also observed a direct effect of Responsibility and Instability on irrational procrastination and an indirect effect of Instability on MPA tendency.

TABLE 3

Zero-order correlations for variables ($N = 1326$)

	1	2	3	4	5	6	7	8
1. Level of physical activity	1							
2. Self-exploration	0.08**	1						
3. Instability	-0.06*	0.22**	1					
4. Possibilities	0.07**	0.65**	0.22**	1				
5. Responsibility	0.14**	0.30**	0.10**	0.23**	1			
6. Self-control	0.18**	0.09**	-0.27**	0.06**	0.14**	1		
7. Mobile phone addiction tendency	-0.09**	-0.09**	0.23**	-0.08**	0.03	-0.48**	1	
8. Irrational procrastination	-0.20**	-0.03	0.30**	-0.06*	-0.11**	-0.63**	0.49**	1

Note: * $p < 0.05$; ** $p < 0.01$.

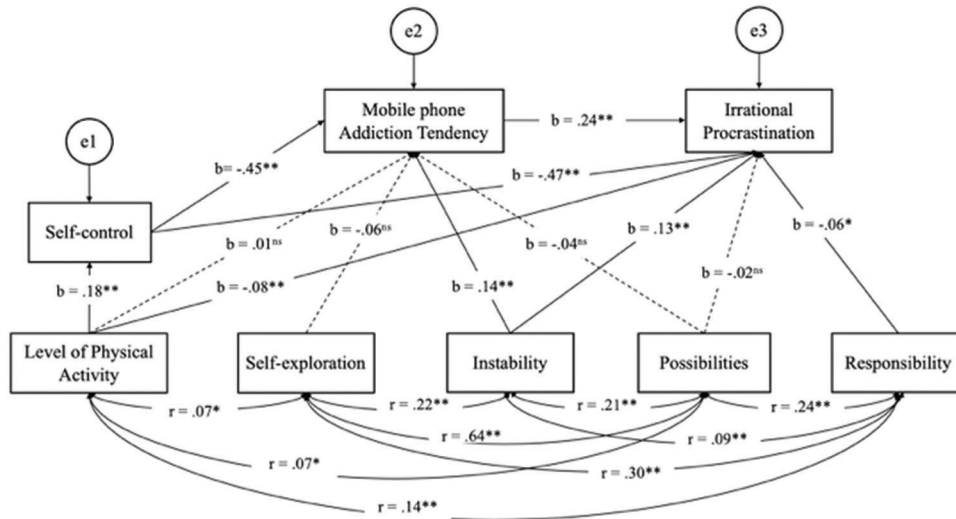


FIGURE 2. The path analysis model.

Note. Dotted lines represent non-significant pathways and solid lines indicate significant ones. $*p < 0.05$; $**p < 0.01$; The values on the arrow represent the standardized path coefficients of significance (r values: coefficients of correlation between the variables; b values: standardized regression weights).

It is worthwhile to note that contrary to our hypotheses, there was no significant effect of Self-exploration and Possibilities on MPA tendency or irrational behavior. Such a finding differs from the observations of previous research [e.g., 16,20] suggesting (i) that higher scores for the Possibilities or Self-exploration domain might be related to adjustment issues and (ii) that a more pronounced sense of possibilities is associated with a lower level of negative emotions and, in turn, fewer behavioral problems [14]. In contrast, higher scores on Instability were linked to both MPA tendency and irrational procrastination in this study, which is in accordance with findings from previous studies [e.g., 14] assuming that emerging adults who adjust

themselves poorly to instabilities in this life period are susceptible to depressive symptoms or behavioral problems.

There are several potential explanations for the prevalence of MPA and irrational procrastination in emerging adults. Growing up in the digital world, emerging adults have easy access and habituate themselves to the use of mobile phones and other electronic devices. Given that mobile phones are used for various purposes (e.g., to gain social support through social media platforms, to be entertained via the internet; [107,108]), they might be utilized in the face of the uncertainty and instability (e.g., the choice of romantic partners or job offers) as an anchor to avoid the feeling of unsettlement, anxiety and depression

TABLE 4

Direct effects & indirect effects in SEM

Path	Direct effects				Indirect effects			
	Coefficient*	S.E.	p	95% CI	Coefficient*	S.E.	p	95% CI
PA level → Self-control	0.18	0.03	0.002	0.13~0.23	No Path			
PA level →MBA tendency	No Path				-0.08	0.01	<0.001	-0.11~-0.06
PA level → Irrational procrastination	-0.08	0.02	0.002	-0.12~-0.04	-0.10	0.02	0.002	-0.14~-0.07
PA level → Self-control → Irrational procrastination	No Path				-0.01	0.002	0.001	-0.17~-0.008
PA level → Self-control → MBA tendency → Irrational procrastination	No Path				-0.003	0.001	0.001	-0.004~-0.002
Self-control → MBA tendency	-0.45	0.03	0.002	-0.50~-0.40	No Path			
Self-control → Irrational procrastination	-0.47	0.03	0.002	-0.53~-0.41	-0.11	0.01	0.002	-0.14~-0.08
MBA tendency → Irrational procrastination	0.24	0.03	0.002	-0.18~-0.29	No Path			
Instability → MBA tendency	0.14	0.03	0.001	0.08~0.20	No Path			
Instability → Irrational procrastination	0.13	0.02	0.002	0.08~0.18	0.03	0.008	0.001	0.02~0.05
Responsibility → Irrational procrastination	-0.06	0.02	0.03	-0.10~-0.08	No Path			

Note: *Standardized coefficients.

or to avoid possible risks or failure that instability could bring. However, such a problematic mobile phone use could take up so much time and psychological energy of emerging adults that they cannot accomplish their goals, which could lead to irrational procrastination behaviors [109]. Both MPA and irrational procrastination can exert a detrimental effect on the mental and physical health of emerging adults but for those emerging adults who scored higher in the subscale of Responsibility, they are more likely to be conscientious in completing tasks in daily life [7], which may be the reason they are less likely to show high levels of irrational procrastination. In addition, the non-significant effect of Possibilities and Self-exploration on both MPA and irrational procrastination might be related to the fact that the negative effects of these two features were balanced by their positive effects on the above-mentioned behavioral problems. This assumption is at least partly supported by findings of a previous study showing that [20] Experimentation/Possibilities is not only positively associated with internalizing problems, but also linked to higher self-esteem and lower social anxiety. Therefore, emerging adults who have a higher level of perceived Possibilities and Self-exploration may be more likely to experience setback but they are also to be more likely to adjust themselves or boost courage to overcome these obstacles in life. Moreover, for emerging adults who are less capable of dealing with the instability of this period, strengthening self-control via regular physical exercise could be one potential solution to protect against the harmful health effects that can occur in emerging adulthood [*i.e.*, 110,111].

The current study had several limitations. Firstly, path analysis can help to reveal associations between specific variables but it does not establish causality nor can it unequivocally establish the direction of observed relationships [112]. Secondly, concerning that the linear model is unified under the assumption of normality, non-normal distributed data could potentially limit the extent to which linear models can be reasonably fitted to data [113]. Thirdly, as we used self-reports to assess our measures of interest, our data can be influenced by different sources of bias (*e.g.*, social desirability bias, response bias, and measurement errors; [114]). In this regard, longitudinal studies are needed to test the causality of the observed relationships. In particular, experimental studies could help to elucidate whether physical exercise interventions can promote emerging adults' well-being and mental health in terms of MPA and procrastination. Moreover, future studies could examine the potential interaction between features of emerging adulthood and personality factors on these behavioral problems and how such phenomena are mediated or moderated by the level of regular PA. Finally, we did not take into account the participants' demographic variables (*e.g.*, gender, and socioeconomic status).

Conclusion

In summary, this cross-sectional study examined the relationship between dimensions of emerging adulthood, level of regular PA, irrational procrastination, MPA

tendency, and trait self-control among Chinese emerging adults via a path analysis approach. The results of our study suggest that specific features of emerging adulthood (*i.e.*, Instability and Responsibility) are associated with adjustment issues (*i.e.*, MPA and irrational procrastination) being prevalent behavioral problems in this stage of life. Furthermore, our study revealed that in emerging adults, higher levels of regular PA via a superior self-control exert a protective effect on specific outcomes of mental health (*i.e.*, irrational procrastination and MPA), although the causality of this observation needs to be established by interventional studies. In this context, we recommend that future studies should also consider the utilization of more objective instruments to assess the regular level of PA and self-control (*e.g.*, accelerometer and Stroop test respectively).

Funding Statement: This study was supported by the Start-up Research Grant of Shenzhen University [20200807163056003]; the Start-Up Research Grant [Peacock Plan: 20191105534C].

Authorship: The authors confirm contribution to the paper as follows: Jin Kuang, Conceptualization, Methodology, Data Curation, Formal analysis, Writing-Original Draft, Writing-Review & Editing, Visualization; Jeffrey Jensen Arnett, Conceptualization, Writing-Review & Editing; Erle Chen, Writing-Review & Editing; Zsolt Demetrovics, Writing-Review & Editing; Fabian Herold, Writing-Review & Editing; Rebecca Y. M. Cheung, Writing-Review & Editing; Daniel L. Hall, Writing-Review & Editing; Yan Luo, Methodology, Formal analysis; Michaela Markwart, Writing-Review & Editing; Markus Gerber, Writing-Review & Editing; Sebastian Ludyga, Writing-Review & Editing; Arthur F. Kramer, Writing-Review & Editing; Liye Zou, Conceptualization, Methodology, Data Curation, Formal analysis, Writing-Original Draft, Writing-Review & Editing, Visualization, Supervision, Project administration, Funding acquisition. All authors reviewed the results and approved the final version of the manuscript.

Conflicts of Interest: The author declare that they have no conflicts of interest to report regarding the present study.

References

1. Arnett JJ. Emerging adulthood: the winding road from the late teens through the twenties. New York: Oxford University Press, 2014.
2. Arnett JJ. Emerging adulthood: what is it, and what is it good for? *Child Development Perspectives* [Internet]. 2007;1(2):68–73. doi:10.1111/j.1750-8606.2007.00016.x.
3. Arnett JJ. *The Oxford handbook of emerging adulthood*. New York: Oxford University Press, 2015.
4. Arnett JJ. Emerging adulthood: understanding the new way of coming of age. 2006. doi:10.1037/11381-001.
5. Arnett JJ, Tanner JL. *Emerging adults in America: coming of age in the 21st century*. Washington, DC: American Psychological Association, 2006.

6. Mitra D, Arnett JJ. Life Choices of Emerging Adults in India. *Emerging Adulthood*. 2021;9(3):229–239. doi:10.1177/2167696819851891.
7. Kuang J, Zhong J, Yang P, Bai X, Liang Y, Cheval B, et al. Psychometric evaluation of the inventory of dimensions of emerging adulthood (IDEA) in China. *International Journal of Clinical and Health Psychology* [Internet]. 2023;23(1):100331. doi:10.1016/j.ijchp.2022.100331.
8. Kuang J, Zhong J, Arnett JJ, Hall DL, Chen E, Markwart M, et al. Conceptions of adulthood among chinese emerging adults. 2022. doi:10.31234/osf.io/d4b6y.
9. Douglass CB. From duty to desire: emerging adulthood in Europe and its consequences. *Child dEvelopment Perspectives* [Internet]. 2007;1(2):101–8. doi:10.1111/j.1750-8606.2007.00023.x.
10. Nelson LJ, Barry CM. Distinguishing features of emerging adulthood: the role of self-classification as an adult. *Journal of Adolescent Research* [Internet]. 2005;20(2):242–62. doi:10.1177/0743558404273074.
11. Arnett JJ. Emerging adulthood: a theory of development from the late teens through the twenties. *American Psychologist* [Internet]. 2000;55(5):469–80. doi:10.1037/0003-066X.55.5.469.
12. Arnett JJ. *Adolescence and emerging adulthood: a cultural approach*. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 2004.
13. Arnett JJ. Conceptual foundations of emerging adulthood. In: *Emerging Adulthood and Higher Education*. New York: Routledge, 2018. p. 11–24.
14. Arnett JJ, Žukauskienė R, Sugimura K. The new life stage of emerging adulthood at ages 18–29 years: implications for mental health. *The Lancet Psychiatry* [Internet]. 2014;1(7):569–76. doi:10.1016/S2215-0366(14)00080-7.
15. Palmeroni N, Claes L, Verschueren M, Bogaerts A, Buelens T, Luyckx K. Identity distress throughout adolescence and emerging adulthood: age trends and associations with exploration and commitment processes. *Emerging Adulthood* [Internet]. 2020;8(5):333–43. doi:10.1177/2167696818821803.
16. Hill JM, Lalji M, van Rossum G, van der Geest VR, Blokland AA. Experiencing emerging adulthood in the Netherlands. *Journal of Youth Studies* [Internet]. 2015;18(8):1035–56. doi:10.1080/13676261.2015.1020934.
17. Ritchie RA, Meca A, Madrazo VL, Schwartz SJ, Hardy SA, Zamboanga BL, et al. Identity dimensions and related processes in emerging adulthood: helpful or harmful? *Journal of Clinical Psychology* [Internet]. 2013;69(4):415–32. doi:10.1002/jclp.21960.
18. Pettit JW, Roberts RE, Lewinsohn PM, Seeley JR, Yaroslavsky I. Developmental relations between perceived social support and depressive symptoms through emerging adulthood: blood is thicker than water. *Journal of Family Psychology* [Internet]. 2011;25(1):127–36. doi:10.1037/a0022320.
19. Arnett JJ, Schwab J. *The Clark University poll of emerging adults: thriving, struggling, and hopeful*. Worcester, MA: Clark University, 2012.
20. Lanctot J, Poulin F. Emerging adulthood features and adjustment: a person-centered approach. *Emerging Adulthood* [Internet]. 2018;6(2):91–103. doi:10.1177/2167696817706024.
21. Wang J, Cheng CT. *The history of the mobile phone in China*. In: *Mobile Communication and Greater China*. New York: Routledge, 2012. p. 78–93.
22. CNNIC. *The 47th China statistical report on Internet development*. In: Center CINI, editor. 2021.
23. Montag C, Wegmann E, Sariyska R, Demetrovics Z, Brand M. How to overcome taxonomical problems in the study of Internet use disorders and what to do with smartphone addiction? *Journal of Behavioral Addictions* [Internet]. 2021;9(4):908–14. doi:10.1556/2006.8.2019.59.
24. White MP, Eiser JR, Harris PR. Risk perceptions of mobile phone use while driving. *Risk Analysis: An International Journal* [Internet]. 2004;24(2):323–34. doi:10.1111/j.0272-4332.2004.00434.x.
25. Billieux J, Van der Linden M, Rochat L. The role of impulsivity in actual and problematic use of the mobile phone. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition* [Internet]. 2008;22(9):1195–210. doi:10.1002/acp.1429.
26. Kiran S, Sanjana J, Reddy N (2019). Mobile phone addiction: symptoms, impacts and causes-a review. *Int Conf Trends Ind Value Eng Bus Soc Innov*, Bangalore, Karnataka, India.
27. Chóliz M. Mobile phone addiction: a point of issue. *Addiction* [Internet]. 2010;105(2):373–4. doi:10.1111/j.1360-0443.2009.02854.x.
28. Kaya F, Bostanci Daştan N, Durar E. Smart phone usage, sleep quality and depression in university students. *International Journal of Social Psychiatry* [Internet]. 2021;67(5):407–14. doi:10.1177/0020764020960207.
29. Peng Y, Zhou H, Zhang B, Mao H, Hu R, Jiang H. Perceived stress and mobile phone addiction among college students during the 2019 coronavirus disease: the mediating roles of rumination and the moderating role of self-control. *Personality and Individual Differences* [Internet]. 2022;185(1):111222. doi:10.1016/j.paid.2021.111222.
30. Li Y, Li G, Liu L, Wu H. Correlations between mobile phone addiction and anxiety, depression, impulsivity, and poor sleep quality among college students: a systematic review and meta-analysis. *Journal of Behavioral Addictions* [Internet]. 2020;9(3):551–71. doi:10.1556/2006.2020.00057.
31. Liu Q-Q, Zhou Z-K, Yang X-J, Kong F-C, Niu G-F, Fan C-Y. Mobile phone addiction and sleep quality among Chinese adolescents: a moderated mediation model. *Computers in Human Behavior* [Internet]. 2017;72(7):108–14. doi:10.1016/j.chb.2017.02.042.
32. Mohammadbeigi A, Absari R, Valizadeh F, Saadati M, Sharifmoghadam S, Ahmadi A, et al. Sleep quality in medical students; the impact of over-use of mobile cellphone and social networks. *Journal of Research in Health Sciences* [Internet]. 2016;16(1):46.
33. Yang S-Y, Chen K-L, Lin P-H, Wang P-Y. Relationships among health-related behaviors, smartphone dependence, and sleep duration in female junior college students. *Social Health and Behavior* [Internet]. 2019;2(1):26. doi:10.4103/SHB.SHB_44_18.
34. HariPriya R, Preetha S, Devi RG. Effect of mobile phone usage before sleep. *Drug Invention Today* [Internet]. 2018;10(11):2255–2257.
35. Huang S, Lai X, Li Y, Luo Y, Wang Y. Understanding juveniles' problematic smartphone use and related influencing factors: a network perspective. *Journal of Behavioral Addictions* [Internet]. 2021;10(3):811–26. doi:10.1556/2006.2021.00048.
36. Canale N, Moretta T, Pancani L, Buodo G, Vieno A, Dalmaso M et al. A test of the pathway model of problematic smartphone use. *Journal of Behavioral Addictions* [Internet]. 2021;10(1):181–93. doi:10.1556/2006.2020.00103.
37. Steel PDG. *The measurement and nature of procrastination*. Ann Arbor, MI: University of Minnesota, 2002.

38. Qian F. Qian taishi hetan draft [M]. Complete library of the four treasures of knowledge. Jinan: Qilu Book Club, 1997.
39. Steel P. The nature of procrastination: a meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychological Bulletin* [Internet]. 2007;133(1):65–94. doi:10.1037/0033-2909.133.1.65.
40. Kroese FM, De Ridder DT, Evers C, Adriaanse MA. Bedtime procrastination: introducing a new area of procrastination. *Frontiers in Psychology* [Internet]. 2014;5:611. doi:10.3389/fpsyg.2014.00611.
41. Schouwenburg HC. Academic procrastination. Procrastination and task avoidance. 1995, 71–96. doi:10.1007/978-1-4899-0227-6_4.
42. Beutel ME, Klein EM, Aufenanger S, Brähler E, Dreier M, Müller KW, et al. Procrastination, distress and life satisfaction across the age range—a German representative community study. *PLoS One* [Internet]. 2016;11(2):e0148054. doi:10.1371/journal.pone.0148054.
43. Ferrari JR, Roster CA. Delaying disposing: examining the relationship between procrastination and clutter across generations. *Current Psychology* [Internet]. 2018;37(2):426–31. doi:10.1007/s12144-017-9679-4.
44. Harriott J, Ferrari JR. Prevalence of procrastination among samples of adults. *Psychological Reports* [Internet]. 1996;78(2):611–6. doi:10.2466/pr0.1996.78.2.611.
45. Cheung RY, Ng MC. Being in the moment later? Testing the inverse relation between mindfulness and procrastination. *Personality and Individual Differences* [Internet]. 2019;141(1):123–6. doi:10.1016/j.paid.2018.12.015.
46. Klassen RM, Ang RP, Chong WH, Krawchuk LL, Huan VS, Wong IY, et al. A cross-cultural study of adolescent procrastination. *Journal of Research on Adolescence* [Internet]. 2009;19(4):799–811. doi:10.1111/j.1532-7795.2009.00620.x.
47. O'Brien WK. Applying the transtheoretical model to academic procrastination. Ann Arbor, MI: University of Houston, 2000.
48. Özer BU (2011). A cross sectional study on procrastination: who procrastinate more. *Int Conf on Education Research and Innovation*, Madrid, Spain.
49. Chun Chu AH, Choi JN. Rethinking procrastination: positive effects of “active” procrastination behavior on attitudes and performance. *The Journal of Social Psychology* [Internet]. 2005;145(3):245–64. doi:10.3200/SOCP.145.3.245-264.
50. Steel P. Arousal, avoidant and decisional procrastinators: do they exist? *Personality and Individual Differences* [Internet]. 2010;48(8):926–34. doi:10.1016/j.paid.2010.02.025.
51. Andreou C. Understanding procrastination. *Journal for the Theory of Social Behaviour* [Internet]. 2007;37(2):183–93. doi:10.1111/j.1468-5914.2007.00331.x.
52. Shi M, Zhai X, Li S, Shi Y, Fan X. The relationship between physical activity, mobile phone addiction, and irrational procrastination in Chinese college students. *International Journal of Environmental Research and Public Health* [Internet]. 2021;18(10):5325. doi:10.3390/ijerph18105325.
53. Shi M, Qian J, Li S, Zhai X, Shi Y, Fan X. The relationship of mobile phone addiction and irrational procrastination in college students: mediating effect of perceived stress. *Journal of Digital Life* [Internet]. 2021;1:6. doi:10.51015/jdl.2021.1.6
54. Burka J, Yuen LM. Procrastination: why you do it, what to do about it now. Cambridge, MA: Da Capo Press, 2008.
55. Flett GL, Blankstein KR, Martin TR. Procrastination, negative self-evaluation, and stress in depression and anxiety: A review and preliminary model. In J. R. Ferrari, J. H. Johnson & W. G. McCown (Eds.), *Procrastination, and task avoidance: Theory, research, and treatment*. New York, NY: Plenum Press, 1995;137–67.
56. Özer BU, Saçkes M. Effects of academic procrastination on college students' life satisfaction. *Procedia-Social and Behavioral Sciences* [Internet]. 2011;12(1):512–9. doi:10.1016/j.sbspro.2011.02.063.
57. Sirois FM. Procrastination and intentions to perform health behaviors: the role of self-efficacy and the consideration of future consequences. *Personality and Individual Differences* [Internet]. 2004;37(1):115–28. doi:10.1016/j.paid.2003.08.005.
58. Sirois FM, Melia-Gordon ML, Pychyl TA. I'll look after my health, later: an investigation of procrastination and health. *Personality and Individual Differences* [Internet]. 2003;35(5):1167–84. doi:10.1016/S0191-8869(02)00326-4.
59. Davey A, Nasser K, Davey S. Gender differential for smart phone addiction and its predictors among adolescents: assessing relationship with self control via SEM approach. *Journal of Indian Association for Child & Adolescent Mental Health* [Internet]. 2020;16(3):80–101. doi:10.1177/0973134220200305.
60. Xiuge Z, Jie Q, Wenyu H. Self-control mediates the relationship between the meaning in life and the mobile phone addiction tendency of Chinese college students. *Studies of Psychology and Behavior* [Internet]. 2019;17(4):536.
61. Wijaya HE, Tori AR. Exploring the role of self-control on student procrastination. *International Journal of Research in Counseling and Education* [Internet]. 2018;2(1):13–8. doi:10.24036/003za0002.
62. Przepiórka A, Błachnio A, Siu NY-F. The relationships between self-efficacy, self-control, chronotype, procrastination and sleep problems in young adults. *Chronobiology International* [Internet]. 2019;36(8):1025–35. doi:10.1080/07420528.2019.1607370.
63. Khang H, Woo HJ, Kim JK. Self as an antecedent of mobile phone addiction. *International Journal of Mobile Communications* [Internet]. 2012;10(1):65–84. doi:10.1504/IJMC.2012.044523.
64. Geng Y, Gu J, Wang J, Zhang R. Smartphone addiction and depression, anxiety: the role of bedtime procrastination and self-control. *Journal of Affective Disorders* [Internet]. 2021;293(4):415–21. doi:10.1016/j.jad.2021.06.062.
65. Muraven M, Baumeister RF. Self-regulation and depletion of limited resources: does self-control resemble a muscle? *Psychological Bulletin* [Internet]. 2000;126(2):247.
66. Baumeister RF, Vohs KD. (Eds.). *Handbook of self-regulation: Research, theory, and applications*. New York: The Guilford Press, 2004.
67. Metcalfe J, Mischel W. A hot/cool-system analysis of delay of gratification: dynamics of willpower. *Psychological Review* [Internet]. 1999;106(1):3–19. doi:10.1037/0033-295X.106.1.3.
68. Norman DA, Shallice T. Attention to action. In: *Consciousness and Self-Regulation*. New York: Springer, 1986. p. 1–18. doi:10.1007/978-1-4757-0629-1.
69. Tangney JP, Boone AL, Baumeister RF. High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. In: *Self-Regulation and Self-Control*. New York: Routledge, 2018. p. 173–212.
70. De Ridder DT, Lensvelt-Mulders G, Finkenauer C, Stok FM, Baumeister RF. Taking stock of self-control: a meta-analysis of how trait self-control relates to a wide range of behaviors. *Personality and Social Psychology Review* [Internet]. 2012;16(1):76–99. doi:10.1177/1088868311418749.

71. Duckworth AL, Taxer JL, Eskreis-Winkler L, Galla BM, Gross JJ. Self-control and academic achievement. *Annual Review of Psychology* [Internet]. 2019;70(1):373–99. doi:10.1146/annurev-psych-010418-103230.
72. De Ridder D, Gillebaart M. Lessons learned from trait self-control in well-being: making the case for routines and initiation as important components of trait self-control. *Health Psychology Review* [Internet]. 2017;11(1):89–99. doi:10.1080/17437199.2016.1266275.
73. Li Q, Xiang G, Song S, Li X, Liu Y, Wang Y, et al. Trait self-control and disinhibited eating in COVID-19: the mediating role of perceived mortality threat and negative affect. *Appetite* [Internet]. 2021;167(1):105660. doi:10.1016/j.appet.2021.105660.
74. Zhong W, Wang Y, Zhang G. The impact of physical activity on college students' mobile phone dependence: the mediating role of self-control. *International Journal of Mental Health and Addiction* [Internet]. 2021;19(6):2144–59. doi:10.1007/s11469-020-00308-x.
75. Zhang R, Chen Z, Hu B, Zhou F, Feng T. The anxiety-specific hippocampus-prefrontal cortex pathways links to procrastination through self-control. *Human Brain Mapping* [Internet]. 2022;43(5):1738–48. doi:10.1002/hbm.25754.
76. Patterson R, McNamara E, Tainio M, de Sá TH, Smith AD, Sharp SJ et al. Sedentary behaviour and risk of all-cause, cardiovascular and cancer mortality, and incident type 2 diabetes: a systematic review and dose response meta-analysis. *European Journal of Epidemiology* [Internet]. 2018;33(9):811–29. doi:10.1007/s10654-018-0380-1.
77. Ekelund U, Brown WJ, Steene-Johannessen J, Fagerland MW, Owen N, Powell KE et al. Do the associations of sedentary behaviour with cardiovascular disease mortality and cancer mortality differ by physical activity level? A systematic review and harmonised meta-analysis of data from 850 060 participants. *British Journal of Sports Medicine* [Internet]. 2019;53(14):886–94. doi:10.1136/bjsports-2017-098963.
78. Buck SM, Hillman CH, Castelli DM. The relation of aerobic fitness to strop task performance in preadolescent children. *Medicine and Science in Sports and Exercise* [Internet]. 2008;40(1):166–72. doi:10.1249/mss.0b013e318159b035.
79. Cooper SB, Dring KJ, Morris JG, Sunderland C, Bandelow S, Nevill ME. High intensity intermittent games-based activity and adolescents' cognition: moderating effect of physical fitness. *BMC Public Health* [Internet]. 2018;18(1):1–4. doi:10.1186/s12889-018-5514-6.
80. Aguirre-Loaiza H, Arias I, Bonilla S, Ramírez R, Ramírez-Herrera S, Nanez J, et al. Effect of acute physical exercise on inhibitory control in young adults: high-intensity indoor cycling session. *Physiology & Behavior* [Internet]. 2022;254(18):113902. doi:10.1016/j.physbeh.2022.113902.
81. Chang Y-K, Etnier JL. Effects of an acute bout of localized resistance exercise on cognitive performance in middle-aged adults: a randomized controlled trial study. *Psychology of Sport and Exercise* [Internet]. 2009;10(1):19–24. doi:10.1016/j.psychsport.2008.05.004.
82. Barella LA, Etnier JL, Chang Y-K. The immediate and delayed effects of an acute bout of exercise on cognitive performance of healthy older adults. *Journal of Aging and Physical Activity* [Internet]. 2010;18(1):87–98. doi:10.1123/japa.18.1.87.
83. Yang G, Li Y, Liu S, Liu C, Jia C, Wang S. Physical activity influences the mobile phone addiction among Chinese undergraduates: the moderating effect of exercise type. *Journal of Behavioral Addictions* [Internet]. 2021;10(3):799–810. doi:10.1556/2006.2021.00059.
84. Yuan Y, Yang J, Wu M. The relationship between physical exercise and mobile phone addiction of college students from low social classes. *International Journal of Physical Activity and Health* [Internet]. 2022;1(2):15. doi:10.18122/ijpah.
85. Fan H, Qi S, Huang G, Xu Z. Effect of acute aerobic exercise on inhibitory control of college students with smartphone addiction. *Evidence-Based Complementary and Alternative Medicine* [Internet]. 2021;2021(1):1–9. doi:10.1155/2021/5530126.
86. Wang X, Zhang C. Research on the exercise intervention of mental health level of mobile phone addiction medical students. *China Higher Medicine Education* [Internet]. 2016;7(9):29–30.
87. Liu S, Xiao T, Yang L, Loprinzi PD. Exercise as an alternative approach for treating smartphone addiction: a systematic review and meta-analysis of random controlled trials. *International Journal of Environmental Research and Public Health* [Internet]. 2019;16(20):3912. doi:10.3390/ijerph16203912.
88. Cao J, Cao G, Zhang Y. The relationship between college students' physical exercise and procrastination tendency: mediating roles of time management disposition. 2018. doi:10.12677/ap.2018.85085.
89. Li C, Hu Y, Ren K. Physical activity and academic procrastination among Chinese university students: a parallel mediation model of self-control and self-efficacy. *International Journal of Environmental Research and Public Health* [Internet]. 2022;19(10):6017. doi:10.3390/ijerph19106017.
90. Ren K, Liu X, Feng Y, Li C, Sun D, Qiu K. The relationship between physical activity and academic procrastination in Chinese college students: the mediating role of self-efficacy. *International Journal of Environmental Research and Public Health* [Internet]. 2021;18(21):11468. doi:10.3390/ijerph182111468.
91. Reifman A, Arnett JJ, Colwell MJ. Emerging adulthood: theory, assessment and application. *Journal of Youth Development* [Internet]. 2007;2(1):37–48.
92. Macfarlane DJ, Lee CC, Ho EY, Chan KL, Chan DT. Reliability and validity of the Chinese version of IPAQ (short, last 7 days). *Journal of Science and Medicine in Sport* [Internet]. 2007;10(1):45–51. doi:10.1016/j.jsams.2006.05.003.
93. Committee IR. Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ)-short and long forms. 2005. Available from: <http://www.ipaq.kise/scoringpdf>.
94. Liang W, Wang DD, Shang BR, Zhang C-Q, Duan YP, Si GY. Further examination of the psychometric properties of the Brief Self-Control Scale: evidence from Chinese athletes and students. *International Journal of Sport and Exercise Psychology* [Internet]. 2022;20(1):16–35. doi:10.1080/1612197X.2020.1827000.
95. Maloney PW, Grawitch MJ, Barber LK. The multi-factor structure of the Brief Self-Control Scale: discriminant validity of restraint and impulsivity. *Journal of Research in Personality* [Internet]. 2012;46(1):111–5. doi:10.1016/j.jrp.2011.10.001.
96. Xiong J, Zhou ZK, Chen W, You ZQ, Zhai ZY, et al. Development of Mobile Phone Addiction Tendency Scale for College Students. *China Journal of Mental Health* [Internet]. 2012;26:222–225. doi:10.1037/t74211-000.
97. Shaw A, Zhang JJ. Psychometric properties of the chinese irrational procrastination scale: factor structure and measurement invariance across gender. *Frontiers in Psychology* [Internet]. 2021;12:4726. doi:10.3389/fpsyg.2021.768581.

98. Kline RB. Principles and practice of structural equation modeling. New York: Guilford Publications, 2015.
99. Byrne BM. Structural equation modeling with AMOS: basic concepts, applications, and programming (multivariate applications series), vol. 396. New York: Taylor & Francis Group, 2010. 7384.
100. Kline RB. Convergence of structural equation modeling and multilevel modeling. In *The SAGE Handbook of Innovation in Social Research Methods*. 2011;562–589. doi:10.4135/9781446268261.n31.
101. Stevens JP. Applied multivariate statistics for the social sciences. New York: Routledge, 2012.
102. Bentler PM, Wu EJ. EQS 6.1 for Windows. Structural equations program manual. Encino, CA: Multivariate Software, 2005.
103. Bollen KA, Stine RA. Bootstrapping goodness-of-fit measures in structural equation models. *Sociological Methods & Research* [Internet]. 1992;21(2):205–29. doi:10.1177/0049124192021002004.
104. Hair Jr, Joseph F, Black William C, Babin Barry J, Anderson Rolph E. Multivariate data analysis. 7th Edition, Prentice Hall, Upper Saddle River. 2009;761.
105. MacKinnon DP, Fairchild AJ, Fritz MS. Mediation analysis. *Annual Review of Psychology* [Internet]. 2007;58(1):593–614. doi:10.1146/annurev.psych.58.110405.085542.
106. Corrêa Ferraz R. Bollen-Stine bootstrapping of the chi-square statistic in structural equation models: the effect of model size. 2020. Available from: <https://scholarcommons.sc.edu/etd/6074>
107. Coyne SM, Padilla-Walker LM, Howard E. Emerging in a digital world: a decade review of media use, effects, and gratifications in emerging adulthood. *Emerging Adulthood* [Internet]. 2013;1(2):125–37. doi:10.1177/2167696813479782.
108. Lopez-Fernandez O, Kuss DJ, Romo L, Morvan Y, Kern L, Graziani P et al. Self-reported dependence on mobile phones in young adults: a European cross-cultural empirical survey. *Journal of Behavioral Addictions* [Internet]. 2017;6(2):168–77. doi:10.1556/2006.6.2017.020.
109. Erdoğan U, Pamuk M, Eren-Yürük S, Pamuk K (2013). Academic procrastination and mobile phone. *International Academic Conference on Education, Teaching and E-learning*, Prague, Czech Republic.
110. Shigeta TT, Morris TP, Henry DH, Kucyi A, Bex P, Kramer AF et al. Acute exercise effects on inhibitory control and the pupillary response in young adults. *International Journal of Psychophysiology* [Internet]. 2021;170(2):218–28. doi:10.1016/j.ijpsycho.2021.08.006.
111. Fortes Lds, Costa MdC, Perrier-Melo RJ, Brito-Gomes JL, Nascimento-Júnior JRA, de Lima-Júnior DRAA et al. Effect of volume in resistance training on inhibitory control in young adults: a randomized and crossover investigation. *Frontiers in Psychology* [Internet]. 2018;9:2028.
112. Petraitis P, Dunham A, Niewiarowski P. Inferring multiple causality: the limitations of path analysis. *Functional Ecology* [Internet]. 1996;10(4):421–31. doi:10.2307/2389934.
113. Cain MK, Zhang Z, Yuan K-H. Univariate and multivariate skewness and kurtosis for measuring nonnormality: prevalence, influence and estimation. *Behavior Research Methods* [Internet]. 2017;49(5):1716–35. doi:10.3758/s13428-016-0814-1.
114. Fernandez-Ballesteros R. Self-report questionnaires. *Comprehensive Handbook of Psychological Assessment* [Internet]. 2003;3:194–221. doi:10.4135/9780857025753.