JOURNAL OF MODERN SOCIAL SCIENCES
Vol. 1, No. 2, Dec. 2024, 198-211
https://doi.org/10.5281/zenodo.14531686

Relationship between physical activity and mobile phone addiction in older adults: a follow-up study

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Abstract

Aim: To explore the longitudinal predictive relationship between physical activity and mobile phone addiction in older adults. Methods: Utilizing the Physical Activity Scale and Mobile Phone Addiction Scale for evaluation, a total of 859 participants from four Jiangxi Province's senior universities were surveyed , Guizhou Province, Hunan Province and Chongqing Municipality were selected as study subjects to carry out two follow-up surveys over a period of six months. RESULTS: (1) The results of repeated measures ANOVA showed that there was no significant difference between pre- and post-measurements of physical exercise and mobile phone addiction. (2) The results of correlation analyses showed that both the simultaneous correlation and the subsequent correlation between physical activity and mobile phone addiction were significant (T1: $r = -0.36$, $P < 0.001$; T2: $r = -0.25$, $P < 0.001$). (3) Cross-lagged regression analysesshowed that after controlling for pretest interpersonal skills, pretest physical activity had a significant negative predictive effect on posttest mobile phone addiction ($\beta = -0.31$, $P < 0.001$); after controlling for pretest physical activity, pretest mobile phone addiction did not have a significant positive predictive effect on posttest physical activity ($\beta = 0.03$, $P < 0.001$). CONCLUSION: Both physical exercise and mobile phone addiction in older adults have some stability, there is an association between physical exercise and mobile phone addiction, physical exercise negatively predicts mobile phone addiction with significance, and mobile phone addiction does not predict physical exercise.

Full Text Article

Keywords: older adults; physical activity; mobile phone addiction; cross-lagged analysis; follow-up study

Introduction

With the booming development of the information age, mobile phones, tablets and other intelligent mobile terminal devices have already replaced the traditional social media to form a new

social network, penetrating into society, life and many other aspects. Based on figures published by the China Internet Network Information Centre (CNNIC), as of June 2024, 99.8% of China's Internet users use mobile phones to access the Internet, and the proportion of Internet users aged 50 and above has increased from 32.5% in December 2023 to 33.3%, with the size of the group of Internet users aged 60 and above exceeding 157 million, and more and more elderly people are active on the Internet platform.(CNNIC： The 49th Statistical Report on the Development of the Internet in China 2022). According to the research report on the online behaviour of middle-aged and elderly people in 2021(Imedia Research | An Analysis of Online Engagement Patterns Among Middle-aged and Senior Populations in 2021- Internet Industry Research Report - IIMedia Report Center,, n.d.). The study shows that the average daily online time of middle-aged and elderly Internet users has exceeded 4 hours, accounting for 51%, which exceeds the national average time of 3.72 hours. While the scale of elderly Internet users and the average time spent on the Internet have reached new heights, the problem of mobile phone addiction is not only intensifying among the young group, but is also gradually becoming prevalent among the elderly group. Mobile phone addiction refers to a pathological dependence and psychological need for individuals to use the Internet excessively, resulting in obvious impairment of occupational and social functions, leading to a loss of control over Internet use behaviour, and the interaction between individuals and modern information technology(Huang Wenying, et al., 2024). and is a negative result of the mutual interaction between individuals and modern information technology(Zhong Dan et al., 2023). It is a negative result of interaction between individuals and modern information technology. Studies have shown that people with smartphone addiction often exhibit uncontrolled behaviors.(Liu Yan et al., 2023). low self-esteem(Wu Yilin et al., 2024). low self-control(Liu et al., 2024). and craving for external dependence(Zeng Chengwei et al., 2024). and a desire for external dependence, are prone to difficulties in emotional regulation(Liu Qian et al., 2024). anxiety, depression, and sleep disorders(Pan Zhiyin et al., 2023). and other diseases. Current research in the field of mobile phone addiction is mostly focused on the youth group, and the focus has not yet been on the elderly, a group in urgent need of attention.(Jia Yu et al., 2023). The focus has not yet been on the elderly, a group in urgent need of attention.

Physical activity is considered to be one of the effective interventions to improve maladaptive behaviours due to its simplicity and cost-effectiveness. Physical activity refers to the physical activities that individuals do in order to improve their fitness, health, physical and mental development, and physical functioning.(Cathro et al., 2024). Physical Activity. Previous studies have shown that physical activity is associated with mobile phone addiction and has a significant negative predictive effect on mobile phone addiction.(Wong et al., 2024). Self-Determination Theory Self-determination theory suggests that(Deci & Ryan, 2008). Physical activity reduces the need for and dependence on external information affairs by satisfying the psychological needs of individuals in the areas of autonomy, competence, and relationships.(R. Zhang et al., 2024). found that mobile phone addiction has a negative impact on adolescent health, and that high levels of physical activity can alleviate the harms of mobile phone addiction by reducing negative emotions. A systematic review(Pirwani & Szabo, 2024). found that interventions using physical activity can enhance psychological needs and physical health, and is an effective measure for preventing undesirable behaviours. Intervention studies have found that at least 5 sessions of moderate-

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intensity physical activity, 3 sessions of vigorous-intensity physical activity, or strength training at least 3 days per week are effective in improving adolescents' mobile phone addiction.(Wu & Chou, 2023; W. Zhang & Xu, 2022). that were effective in improving mobile phone addiction in adolescents. It was hypothesised that physical activity would negatively predict mobile phone addiction in older adults.

Mobile phone addiction and physical activity may not be a simple one-way relationship. Mobile phone addiction, as an undesirable psychological behaviou Embodying the compulsive, dependent and impulsive characteristics of the individual, causing excessive focus on the mobile phone screen, increasing sedentary time and screen-front behaviours, and affecting physical activity activation(Ma et al., 2022) . Social substitution hypothesis(Derrick et al., 2009). It is believed that human beings are social animals, and individuals tend to seek social substitutes to comfort their hearts when they feel lonely, and the elderly in the retirement stage are affected by many factors and are a high incidence group of negative emotions such as loneliness, depression, and stress.(Huang Wenying et al., 2024). In addition, smartphones successfully meet the social needs of the elderly and relieve stress, anxiety and other negative emotions. However, the fun, entertainment and strong temptation of various APPs on mobile phones can easily lead the elderly to fall into the quagmire of mobile phone addiction, which reduces the motivation of individuals to participate in physical exercise and makes them lack of perception of physical exercise. Compared with participating in physical exercise, it is easier to use mobile phones to spend leisure time and feel spiritual happiness.(Liu Jie, 2021). The empirical studies have reached similar conclusions. Empirical studies have also reached similar conclusions, suggesting that mobile phone addiction reduces individuals' motivation for physical activity, and ultimately leads to motivation for physical activity(Demetrovics et al., 2022). and ultimately leads to a decrease in motivation for physical activity. Another viewpoint is that although mobile phone addiction triggers sedentary and sedentary problems, which have an impact on an individual's physical activity, this impact does not necessarily lead to significant changes in physical activity. There is no significant difference in physical activity between addicts and non-addicts(Dang et al., 2018). Considering the specificity of the elderly population, whether mobile phone addiction could be a hindrance to their physical activity is a question that deserves to be explored in depth. It is hypothesised that mobile phone addiction negatively predicts physical activity.

There is no conclusive evidence on whether there are gender differences in physical activity and mobile phone addiction. Regarding gender differences in physical activity, some scholars believe that there are gender differences in physical activity and that men are generally more active in physical activity than women(Huang Wenying et al., 2024). Some scholars believe that there are gender differences in physical activity and that men are generally more active than women. There are also studies that suggest that there are no significant gender differences among older adults, and that the proportion of female older adults participating in physical activity is increasing(Lin Zhengmei et al., 2018). The gender difference in mobile phone addiction is not significant in the elderly population. With regard to gender differences in mobile phone addiction, research results are also inconsistent, with one viewpoint suggesting that there is no gender difference in mobile phone addiction, with males being slightly more likely than females to be addicted to mobile phones(Bo Yang, 2022). Another viewpoint is that there are gender differences in mobile phone

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addiction, and women are more likely to be addicted to using mobile phones online(Huang Weiwei, 2021). The other view is that there is a gender difference in mobile phone addiction and women are more likely to be addicted to using mobile phones online. Therefore, further research is needed to verify the existence or otherwise of gender differences in both physical exercise and mobile phone addiction and their specific manifestations, especially in the elderly group, where empirical research is even more lacking.

Whether physical activity and mobile phone addiction are unidirectional or bidirectional for the elderly group has not yet been determined. Throughout the previous studies, the research on physical activity and mobile phone addiction mainly focuses on the adolescent group, with less attention paid to the elderly group, and most of them are cross-sectional studies, and few scholars have conducted longitudinal studies. Therefore, in order to examine the relationship between physical activity and mobile phone addiction, the present study established a cross-lagged model to investigate the gender differences in mobile phone addiction, and conducted a 6-month longitudinal study divided into 2 phases of follow-up surveys in order to examine the interrelationships and predictive relationships between the two.

Objects and Methods

Objects

Using convenience sampling method, a survey was conducted between June and December 2023 on a total of 859 students from one senior university in each of Jiangxi Province, Guizhou Province, Hunan Province, and Chongqing Municipality. Inclusion criteria: (1) age ≥ 60 years; (2) attending the senior university for ≥ 6 months; (3) clear cognitive function and state of consciousness. Exclusion criteria: (1) presence of cognitive impairment or major mental illness; (2) hearing or speech impairment; (3) suffering from major diseases. The survey was entrusted to the alumni and the resources of the research group to contact the local senior university to conduct the questionnaire survey, and all the subjects gave informed consent and participated voluntarily. A total of 2 questionnaire surveys were conducted before and after, with an interval of 6 months. The 1st survey was conducted in June 2023, and 1,342 questionnaires were obtained, with 1,154 valid questionnaires and an effective rate of 85.9%; the 2nd survey was conducted in December 2023, and 1,006 questionnaires were obtained, with 895 valid questionnaires and an effective rate of 88.9%, and the specific information is shown in Table 1. In addition, after analysing and testing, the difference between the analysed sample and the attrition sample on the 2 variables was not significant ($p>0.05$), indicating that the study was unstructured attrition. All subjects who participated in the research have been fully informed about the study and voluntarily participated in the research study.

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Table 1
Demographic variables of physical activity and mobile phone addiction in older adults

variant	typology	quorum	per cent
distinguishing between the sexes	male	397	46.20%
	women	462	53.80%
household registration	countryside	260	30.30%
	municipalities	599	69.70%
academic qualifications	Primary and below	298	34.70%
	junior high school	366	42.60%
	High school or secondary school	106	12.30%
	College and above	89	10.40%
incomes	2000 and below	307	35.70%
	2001-3000	236	27.50%
	3001-4000	218	25.40%
	4000 and above	98	11.40%

Methodology

Physical Activity Scale Leung Tak-ching was selected as the choice for the(Liang Deqing, 1994). The revised physical activity scale. The scale is a unidimensional scale. A five-level Likert scale was used. The physical activity level of an individual is evaluated by accumulating the scores of the three indicators. The higher the score, the higher the amount of physical activity in which the individual participates. In this study, the Cronbach's alpha coefficients were 0.829 (T1), 0.883 (T2).

Mobile phone addiction scale The mobile phone addiction tendency scale compiled by Xiong Jie et al. was used and modified according to the study subjects and problems(Xiong Jie et al., 2012). The mobile phone addiction tendency scale compiled by Xiong Jie et al. was used and modified accordingly based on the research subjects and problems. The scale has 16 entries and contains four dimensions. A five-point Likert scale was used, with higher scores representing higher levels of problematic mobile phone use. The Cronbach's alpha coefficients were 0.876 (T1), 0.944 (T2).

Measurement process

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Before starting the test, all classroom leaders or classroom teachers who participated in the survey were trained in order to guarantee the accuracy and consistency of the data. The Questionnaire Star platform was selected for data collection. The tests were all organised on a class-by-class basis to ensure the consistency of data sources. Meanwhile, to ensure the standardisation and accuracy of the tests, both tests were executed by the same main test person. During the testing process, the main test person clearly explained to the participants important information such as the purpose of the survey, the principle of voluntary participation, anonymity, confidentiality of data and storage methods. All subjects could voluntarily withdraw from the test at any time. Necessary assistance was provided throughout the process of completing the questionnaire to those who were unable to complete it on their own.

Data processing and analysis

SPSS 26.0 software was used for descriptive statistics, reliability and validity analysis, repeated measures ANOVA, and cross-lagged analysis of data.

Common method bias test

The Physical Activity Scale and the Subjective Exercise Experience Scale were assessed using the Harman one-way test. The results showed that there were two factors with eigenvalues greater than 1. Of these, the total variance explained by the first factor was 35.087% and 33.529%, respectively, both lower than the critical value(Zhou Hao, 2004) . This indicates that there was no serious problem of common methodological bias in this study.

Results

Stability and gender differences in physical activity and mobile phone addiction

Physical activity and mobile phone addiction were used as dependent variables, time of testing (pre-test T_1 and post-test T_2) as a within-subjects variable, and gender as a between-subjects variable. Repeated measures ANOVA was performed. The results showed that the main effect of physical activity at test time was not significant, $F=0.03$, $p>0.05$; the main effect of gender was not significant, $F=0.04$, $p>0.05$; and the interaction between physical activity test time and gender was not significant, $F=0.23$, $p>0.05$. The main effect of mobile phone addiction at test time was not significant, $F=0.21$, $p>$;0.05; the main effect of gender was not significant, $F=0.01$, $p>0.05$; the interaction between time of measurement of mobile phone addiction and gender was not significant, $F=0.03$, $p>0.05$.

Correlation analysis between pre- and post-test physical activity and mobile phone addiction

Measures of physical activity showed significant negative correlations with mobile phone addiction at different time points. Specifically, there was a significant correlation between the level of physical activity in the previous test and the level of mobile phone addiction in the next test, and vice versa, with the level of mobile phone addiction in the previous test showing a significant correlation with the level of physical activity in the next test. This suggests that physical activity

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and mobile phone addiction are not only correlated at one point in time, but that their relationship is also stable across time, satisfying the conditions for conducting cross-lagged analyses. The results of the correlation analysis are presented in Table 2.

Table 2

Descriptive and correlational analyses of physical activity, mobile phone addiction in older adults (*r,* n=859)

variant	$\bar{x} \pm s$	T1 Physical exercise	T2 Physical exercise	T1 Mobile phone addiction
T1 Physical exercise	18.89±25.38			
T2 Physical exercise	19.00±28.50	.37***		
T1 Mobile phone addiction	2.88±0.80	-.36***	-.16***	
T2 Mobile phone addiction	2.90±0.81	-.48***	-.25***	.58***
F-value		0.19		0.15
p-value		0.667		0.696
η2		<0.001		<0.001

Note: T1, 1st measurement; T2, follow-up measurement after 6 months,* P<0.001.**

Cross-lagged analysis of physical activity and mobile phone addiction in older adults

First, the predictive effect of physical activity on mobile phone addiction was examined. When T2 mobile phone addiction was used as the dependent variable, demographic variables were introduced into the regression model as control variables to control for the potential effect of demographic variables; then T1 mobile phone addiction and T1 physical activity were included in the regression equation as the second level of variables; the results showed that, after controlling for demographic variables and T1 mobile phone addiction, T1 physical activity could significantly negatively predict T2 mobile phone addiction (β = -0.31 , p<0.001). Next, the predictive effect of mobile phone addiction on physical activity was examined in the same way using T2 physical activity as the dependent variable. The results showed that T1 mobile phone addiction did not predict T2 physical activity after controlling for demographic variables and T1 physical activity (β=0.03, p>0.05). The details are shown in Figure 1.

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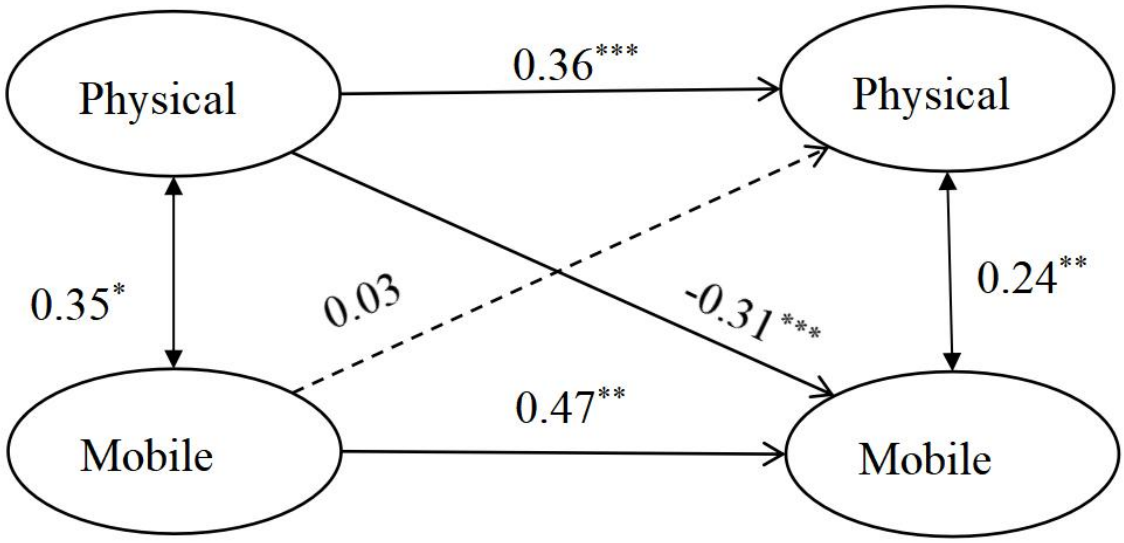

Figure 1

Cross-lagged analysis of physical activity and mobile phone addiction

Discussion

The results of the repeated measures ANOVA showed a degree of stability in physical activity among older adults, with no statistically significant difference between the 2 scores, a finding that is consistent with the results of previous studies(Bo Yang, 2022) . Intrinsic Theoretical Structure of Lifelong Physical Activity Habits(Shao Weide, 2003). It is believed that an individual's daily behaviour is characterised by temporal stability. Physical activity is often considered to be an activity that is influenced by individual preferences, motivation, and personality traits. Individuals tend to maintain a consistent pattern of behaviour, including the habit of adhering to physical activity in daily life, and the stability of this habit may stem from the individual's behavioural preferences and perceptions, as well as the perceived value of physical activity and the pursuit of physical health and mental pleasure. In addition, there is no gender difference in physical activity among older adults, which is consistent with the findings of Tao Baole(Tao Baole et al., 2023). and Chen Xiaoan et al.'s study, which is inconsistent and supports Zhang Xinhui's(Zhang Xinhui et al., 2022). 's point of view. The possible reason for this is the different sources of sample data. The sample data in this paper all came from the University of the Elderly, which is a field that provides a place for the elderly to continue their studies and social activities, and in this environment, it may promote the importance of physical and mental health and active participation in physical activity for the elderly(Chen Huijuan, 2021). and thus encourages men and women to be equally active in physical activity, reducing gender differences. In addition, compared to other social groups, older

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people may be less affected by gender roles and social pressures as they age age age(Cai Zhenghua, 2023) . Increasing age and changes in the lives of older people may also make them less subject to social expectations and pressures, leading them to show greater freedom and flexibility in physical activity, indicating gender convergence. In summary, physical activity among older adults remains relatively stable over time.

Repeated measures ANOVA results showed a degree of stability in mobile phone addiction among older adults, with no statistically significant differences between the 2 scores. This finding is consistent with previous research(Bo Yang, 2022) . Rational addiction theory proposes(Rogeberg, 2020). that individuals weigh the long-term effects, immediate benefits, and risks of addictive behaviours holistically. Based on this theory, it can be inferred that individuals will decide the frequency and intensity of their mobile phone use based on the assessment of benefits and risks. Given the multifunctionality of mobile phones, it has a relatively stable rewarding value for users, and therefore, individual mobile phone use behaviours show a certain degree of stability. In addition, mobile phone addiction is regarded as a type of behavioural addiction, and addictive behaviours usually originate from long-established habits, and since a habit is an ingrained behavioural pattern, an individual's mobile phone addictive behaviours may similarly exhibit a certain degree of stability. Therefore, mobile phone addictive behaviours may be influenced by a combination of an individual's assessment of risk and reward as well as the power of habit to exhibit a certain degree of stability. In addition, this study found that the gender main effect of mobile phone addiction in older adults was not significant, which is consistent with the results of previous studies(Huang Wenying, et al., 2024), which is consistent with the findings of Tong Yuantian(Tong Yuantian et al., 2019). et al.'s findings. According to the technology acceptance model(Zhang Pei, 2017). individuals' willingness to adopt new technologies depends largely on the impact of their perceptions of the usefulness and convenience of the technology. Gender is not an important determinant of mobile phone addiction; for the elderly, mobile phones serve to relieve their loneliness and isolation. It goes without saying that older people usually have a higher interest in new things, making them more likely to be at high risk for mobile phone dependence. Although factors such as an individual's personality traits can also have an impact, it is a smaller one. With the advancement of technology and the prevalence of smartphones, older people's acceptance of mobile phones has gradually increased, and their exposure to and use of mobile phones has increased, making them likely to be more likely to become dependent on mobile phones. And in the context of this general acceptance and use of mobile phones, gender differences become less pronounced in terms of mobile phone addiction. In addition, older adults may tend to live similar lifestyles as they age. For example, retirement provides older adults with more free time, while their social circles may gradually shrink. These lifestyle changes may result in older adults showing similar behavioural patterns in mobile phone use. In summary, older adults' propensity for mobile phone addiction will remain relatively stable over time.

The results of cross-lagged regression analysis found that physical activity had a significant negative predictive effect on mobile phone addiction, indicating that physical activity in the pre-test predicted mobile phone addiction in the post-test, which is consistent with the health behaviour theory(Klusmann et al., 2021) The health behaviours of individuals influence each other to a certain extent. Physical activity, as a positive health behaviour, may motivate older adults to pay more

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attention to physical health and reduce mobile phone addiction. It also validates the applicability of the De la Grandville hypothesis hypothesis in the field of physical activity(Chen Xiaoling, 2013). According to the de la Grandville hypothesis hypothesis, individual engagement in exercise in specific activities reduces the number of hours spent on other activities, and as older adults increase their engagement in physical activity, they may reduce the amount of time spent on their mobile phones and the frequency of their use. Physical activity is often accompanied by an element of social interaction, which provides older adults with the opportunity to interact with others, and this social interaction can help to reduce their dependence and need for mobile phone use, thereby reducing the likelihood of mobile phone addiction. Physical activity as part of an active lifestyle Older adults may be more concerned with physical fitness and active living when engaging in physical activity. They are more inclined to invest time in exercise and less time in mobile phone addiction to maintain good health and vitality. Good health behaviours, especially moderate physical activity, have significant positive effects on alleviating mobile phone addiction among older adults, and appropriate physical activity not only helps to alleviate negative emotions, but is also a key method to correct an individual's addictive behaviour. According to the theory of network use and satisfaction(Lu Heng, 2011) , the individual's psychological needs such as social and entertainment are satisfied in the process of using the network, and this satisfaction may increase the frequency of the individual's use of network devices such as mobile phones. This increases the risk of mobile phone addiction. In contrast, physical activity not only helps to reduce individuals' negative emotions, but also satisfies their psychological needs. Participation in physical activity not only reduces the frequency of individuals using smartphones, but also has a positive effect on alleviating mobile phone addiction by increasing the efficiency of dopamine transmission in the brain. By satisfying psychological needs, reducing negative emotions, and enhancing the body's dopaminergic signalling capacity, physical activity provides an effective way to improve an individual's addiction. In view of this, it is recommended that the elderly actively participate in community-organised sports activities to expand their social circle through exercise, which is not only beneficial to their physical and mental health, but also helps them to better integrate into society and enjoy a happy old age.

This study explored the quasi-causal relationship between physical activity and mobile phone addiction among older adults through a longitudinal follow-up survey and the construction of a cross-lagged model to provide empirical evidence and support for the prevention and intervention of mobile phone addiction. However, there are still some limitations: first, the sample is not representative enough. Only some members of the University of the Elderly were selected. In order to improve the external validity of the study and to further deepen the understanding of the phenomenon of mobile phone addiction among the elderly, future studies should expand the coverage of the sample to include different regions, different types of elderly groups, and diversified contextual characteristics, so as to explore and analyse more comprehensively the influencing factors and potential intervention strategies of mobile phone addiction. Secondly, as the time and frequency of the surveys were limited, future studies could explore the link between physical activity and mobile phone addiction more comprehensively by extending the duration of the follow-up surveys and increasing the frequency of the surveys, so that changes in these variables over time can be observed more precisely.

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Conclusion

Physical activity and cell phone addiction are both stable in older adults, there is an association between physical activity and cell phone addiction, physical activity negatively predicts cell phone addiction with significance, and cell phone addiction does not predict physical activity.

Acknowledgment

All contributions of the third parties can be acknowledged in this section.

Conflict of Interest

The authors declare no conflict of interest.

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