



A Narrative Review: Smartphone Addiction and Physical Inactivity among Adolescents

Sebuah Tinjauan : Kecanduan Gadget dan Ketidak Aktifan Fisik Pada Remaja

Rezky Aulia Yusuf^{1*}, Musfirah Ramadhani Syamsir¹, Fariyah Muhsana³, Andi Sani Silwanah⁴

^{1,2,3}Study Program in Public Health, Faculty of Public Health, Universitas Muslim Indonesia, Jl. Urip Sumohardjo KM. 5, Makassar, 90231, Indonesia, email: rezkyauliyusuf@umi.ac.id, musfirahsyamsir@gmail.com, fariyahusana@gmail.com

⁴Makassar College of Health Science, Jalan. Maccini Raya No. 197, Sinrijala, 90231, Makassar, Indonesia, email: sani.silwanah@gmail.com

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Rezky Aulia Yusuf,
rezkyauliyusuf@umi.ac.id,
Orcid ID: 0000-0001-8593-0220

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ABSTRACT

Background: Physical inactivity is one of the causes of non-communicable diseases and is a global public health problem. Numerous studies mentioned that teenagers spend their leisure time in engaging sedentary behavior and smartphone addiction is the primary cause of physical inactivity.

Objective: This narrative review aims to review the association between smartphone addiction and physical inactivity among adolescents, as well as some solutions that have been carried out to overcome this problem from previous studies.

Methods: The search included electronic bibliographic databases from PubMed and Google Scholar, published from 2015-2021. In total, 8 cross-sectional studies met the inclusion criteria of this review.

Results: Adolescents who reported being addicted to smartphone were more likely to engage in sedentary behavior and be physically inactive. Mental health problems such as anxiety, depression, fear, and other mental depression mediated this association. Also, smartphone addiction can be reduced by increasing sports participation and involvement in physical activity among adolescents. Educational institutions and parents can use sports and recreational activities as intervention strategies to overcome smartphone addiction among the adolescent population.

Conclusion: This study highlights the association between smartphone addiction and physical inactivity. Physical activity and sports participation may have the potential to prevent smartphone addiction among adolescents

Keywords: *Adolescent, physical inactivity, smartphone addiction*

ABSTRAK

Latar Belakang: Kurangnya aktivitas fisik merupakan salah satu penyebab penyakit tidak menular dan merupakan masalah kesehatan masyarakat global. Sejumlah penelitian menyebutkan bahwa remaja menghabiskan waktu luang mereka untuk melakukan perilaku menetap dan kecanduan smartphone adalah penyebab utama kurangnya aktivitas fisik.

Tujuan: Tinjauan naratif ini bertujuan untuk meninjau hubungan antara kecanduan smartphone dengan ketidakaktifan fisik pada remaja, serta beberapa solusi yang telah dilakukan untuk mengatasi masalah ini dari penelitian sebelumnya.

Metode: Pencarian termasuk database bibliografi elektronik dari PubMed dan Google Scholar, diterbitkan dari 2015-2021. Secara total, 8 studi *cross-sectional* memenuhi kriteria inklusi dari tinjauan ini.

Hasil: Remaja yang dilaporkan kecanduan smartphone lebih cenderung terlibat dalam perilaku menetap dan tidak aktif secara fisik. Masalah kesehatan mental seperti kecemasan, depresi, ketakutan, dan depresi mental lainnya dimediasi asosiasi ini. Selain itu, kecanduan smartphone dapat dikurangi dengan meningkatkan partisipasi olahraga dan keterlibatan dalam aktivitas fisik di kalangan remaja. Institusi pendidikan dan orang tua dapat menggunakan kegiatan olahraga dan rekreasi sebagai strategi intervensi untuk mengatasi kecanduan smartphone di kalangan populasi remaja.

Kesimpulan: Penelitian ini menyoroti hubungan antara kecanduan smartphone dan aktivitas fisik. Aktivitas fisik dan partisipasi olahraga berpotensi mencegah kecanduan smartphone di kalangan remaja.

Kata kunci: *kecanduan smartphone, ketidakaktifan fisik, remaja*

INTRODUCTION

Over the past few decades, the world has faced serious health-related problems due to technological advances. One of the challenging concerns is the increasing addiction to smartphone technology which reduces involvement in physical activity and deserves attention. Research shows that smartphone addiction is associated with negative impacts on psychophysical health and social well-being. For example, smartphone addiction can cause depression, anxiety, sleep disturbances¹ and lack of self-control² or low emotional intelligence³. In addition, a positive relationship between smartphone addiction was found with shyness and feelings of loneliness⁴, suicidal behavior⁵, and stress⁶.

Smartphone addiction can limit social interaction and reduce academic performance which ultimately leads to problems in social relationships⁷. Moreover, in most cases, smartphone addiction causes some common health-related problems such as memory impairment, decreased attention, headaches, fatigue, ear warming, and hearing loss⁸. In particular, insufficient physical activity is believed to be detrimental to both physical and mental health⁹. Evidence, in this case, reports that 80.4% of schoolchildren in Southeast Asian countries are not physically active^{10,11} and overall 80% of the world's youth are inactive¹².

Physical activity and smartphone addiction are considered two independent

variables related to health but are related to each other. That is the reason researchers have become interested in examining the potential link between physical activity and smartphone addiction. Physical activity or sports participation can be used as intervention strategies to treat the addiction. Support for this idea arises from previous research showing the beneficial effects of exercise on psychological problems such as anxiety, depression, and stress¹³⁻¹⁶, and sleep¹⁷. In this case,¹⁸ conducted a trial to test the results of a 12-week exercise program on mood, anxiety, depression, and self-control. Eighty-two participants were randomly divided into experimental and control groups. Research tools such as the "Mood State Profile, State-Treat Anxiety Inventory, Beck Depression Inventory, and Tennessee Self-Concept Scale" were administered at the varicose veins time point during the 12-week intervention period and for one year of follow-up. The results showed a significant increase in psychological variables which also remained higher during the one-year follow-up of the intervention. These findings determine the short-term and long-term positive psychological indications of the physical activity program¹⁹.

The above arguments help researchers assume that anxiety, stress, depression, and sleep deprivation may be potential psychopathological variables for smartphone addicts. In contrast, an active lifestyle, physical activity, or participation in

sports may play a role in reducing anxiety, stress, depression, and bringing about improvements in poor sleep, mood, and self-esteem. These considerations are increasingly leading to the belief that those who are highly involved in exercise, physical activity, and exercise may have a lower risk of smartphone addiction. In particular, those who exercise regularly have much better psychological health than those who do not exercise²⁰. These results collectively provide a basis for supporting physical activity as a protective measure against smartphone addiction.

METHODS

In this review, we adapted the study inclusion criteria as follows; 1) full article in English, 2) published in 2015 to December 2021, 3) assess the effect of physical activity, sports participation on smartphone addiction or vice versa, 4) cross-sectional study 5) study sample was adolescents in school, 6) published in a peer review journal or internationally referenced journal, and 7) conducted in which country even. Exclude criteria; theses, dissertations, editorials, letters, brief reports, books or book chapters, conference proceedings, meeting abstracts, pilot studies, guidance statements, and studies reporting unclear methodologies are not included in this review.

Search Strategy

Relevant articles are systematically searched using online databases such as

PubMed and Google Scholar. The search term consists of two sets of keywords; namely, keywords related to smartphone addiction ("smartphone addiction") OR smartphone addiction "social media addiction". Physical activity ("Physical activity"/Physical activity, OR Sports, OR Sedentary behavior ("sedentary behavior"). The search function consists of a mesh-term which is obtained by combining one keyword from each of the two sets with the word 'AND'. It generates 15 independent search phrases.

Study Selection

A list of eligible studies has been selected and duplications removed via the Mendeley software. A three-phase screening strategy was executed by the authors including, title of all articles, abstract, and full-paper. Irrelevant articles were removed and a final list of articles selected for inclusion in this review. In the event of differences regarding study selection, the two experts (first and second authors) discussed and finalized the decision by mutual agreement. The selected articles are then further assessed based on predetermined quality assessment criteria.

Quality Rating

Study quality acceptable for this review was evaluated based on an 8-item study assessment tool. The first 7 items were adopted from quality assessment tools previously used by meta-analytic studies and systematic reviews^{21,22}. In addition to these 7 items, one more item (item number 8) was added in the assessment tool to

evaluate whether a valid instrument was used to measure smartphone addiction in this study. Finally, the assessment tool consists of the following 8 items. The assessment tool items were, "1) studies that had a defined sample, 2) studies that had a representative sample, 3) blinded raters, 4) reported measures of smartphone addiction and relevant physical activity, 5) adequate sample size, 6) statistical adjustment for covariates, 7) validated PA measures"²¹. The 8 items we added are valid sizes.

Score 1 for 'Yes' or 0 for 'No' are assigned to 8 items and combined to achieve

We screened 345 articles based on the eligibility criteria for this review. There were 37 full articles were evaluated for eligibility. In the final selection, 8 studies were found to be critically relevant. After critical assessment, the 8 studies were found

a total score of 8. The scoring system involved, a) the total score achieved by each study, b) divided by the total number of items, and c) multiplied by one hundred. Studies that scored 0-33%, 34-66%, and 67-100% were classified as poor, moderate, and good quality studies, respectively. Studies classified as fair and good were deemed eligible for inclusion in this review. Studies that had a high risk of bias and significant fatal flaws that negatively affected the study's internal validity were excluded.

RESULTS AND DISCUSSION

to be suitable for the category of fair or good quality which was finally decided to be included in the synthesis. The study selection process was completed according to PRISMA guidelines.

Table 1. Matrix of research results

Author / Year	Country	Sample size, Age, Gender	Measuring instrument	Analysis and Test	Findings
Haug, et al., (2015)	Switzerland	1519 school students (boys = 48.2%, girls = 51.8%) Mean age 18.2 ± 3.6 years	SAS-SV (German version), Demographics PA/week	Logistics Regression Analysis	Lower PA level (OR= 0.95, p < .02) and higher levels of stress (OR = 2.14, p < .01) were significantly associated with smartphone addiction.
Kim et al., (2015)	South Korea	110 students (male = 67, female = 43) Age range = 19-25 years	SAPS, Pedometer, Body Composition, Anthropometer PA/week (walking steps and calorie consumption)	Kruskal–Wallis test, Chi-square test	Addicted users are at high risk found with significantly lower average walking steps and calorie/day consumption (p < 0.001). Increasing use of smartphones and minimizing walking are factors that have the potential to risk smartphone addiction.
Author / Year	Country	Sample size, Age, Gender	Measuring instrument	Analysis and Test	Findings
Alosaimi et al., (2016)	Saudi Arab	2367 students (male = 43.6 %),	PUMP Scales (Arabic	Descriptive Statistics	A positive relationship was found between

		Age range 19-25 year	dental	Version)	Student's t-test, one-way NOVA, Karl-Pearson Correlation Coefficient	smartphone addiction and negative lifestyles, for example, decreased sleep, energy, and exercise, weight gain and fast-food consumption (r= 0.598, p < .000).
Venkates et al., (2017)	Saudi Arab	205 students (male = 53.44%, female = 46.56%).		SAS-SV Demographic Information, BMI PA/week	Pearson's Correlation.	Higher level of intelligence-telephone use was significantly associated with higher levels of stress and body mass, and lower levels of physical activity (r = 0.985, p < .000).
Gumusgul (2018).	Turkey	225 students (male = 136, female = 119), Age range = 20-25 years		SAS-SV Turkish Version	One-way ANOVA Independent Sample t-test	Smartphone addiction scores were significantly higher in students who did not participate in recreational sports (t = -2.57, p < 0.05).
SC et al., (2016)	Romania	256 school children (boys = 126, girls = 132), Age range = 9-16 years		BASS, DS	t test	Higher smartphone use was significantly associated with lower participation in sports or physical activity (p = .042)
Penglee et al., (2019)	United States and Thailand	US Health Science students = 242 Thai =194		Online Survey PA/week	Chi-square test Two-way direction ANOVA	Greater smartphone use is inversely related to lower physical activity among Thai students ($\chi^2= 10.55$, p < 0.01) but not in US students

Abbreviation: PA," Physical Activity" or Physical Activity; SAS-SV," Smartphone Addiction Scale for Adolescents (SAS-SV)"; SAPS, Smartphone Addiction Prone Scale; PUMP "Problematic Use of Mobile Phones", Problematic Cell Phone Use; BPFT, Brockport Fitness Test; BASS, Brief Addiction to the Smartphone Scale; DS, Deprivation Sensation

According to geographic location, two studies were conducted in European countries such as Switzerland²³, and Romania²⁴. Two studies were conducted in the United States, and the other four studies were conducted in Asian countries including South Korea²⁵, Turkey²⁶, and Saudi Arabia^{27,28}.

All studies used a convenience sampling technique to select participants from the target population. Three studies took students from 19 to 25 years old^{25,27}, and 20-25 years²⁶, each. One study consisted of students from a dental college with an average age of about 23.2 years²⁸. Two studies were conducted involving students from schools with an average age of 18 years²³ and with an age range of 19-16 years²⁴. The other two studies did not mention the age range for their sample of the student population. All studies involved participants belonging to both sexes but the representation of men and women was different. The age ranges included in the studies indicate that all eight studies involved a population of adolescent and young students. Thus, the findings from this study cannot be generalized to late adults, the elderly, and the general population. In addition, during the literature search process, researchers were unable to find any reviews or meta-analytic studies that included articles published in English journals that assessed the association between physical activity and smartphone addiction in the student population.

Study Quality

Based on the quality assessment tool used for the review, two of the eight studies

were classified as good quality while the other six studies were of moderate quality (see table 2). Furthermore, two studies had a lower risk of bias when reporting findings on student response data^{23,25}. The research questions were clear and data were collected using primary sources (i.e., direct answers from participants). The samples from both studies were well defined; a valid and reliable measurement tool, statistically adjusted covariates in the analysis, and reporting relevant measures of physical activity and smartphone addiction. None of these studies had a fatal error that increased the risk of bias. One of the two studies also used objective measures of physical activity such as the Pedometer and In Body analyzer²⁵.

The other six studies in this review were identified as having moderate reporting bias for the following reasons; 1) used an inadequate sample size, 2) did not include covariates in the analysis, 3) did not use a valid and reliable measure of SA (smartphone addiction) or PA (physical activity). However, the fair quality of the study can be supported by the following points 1) collecting data directly from participants, 2) using one of the valid SA or PA measures. All articles were selected using a defined sample size and collected data systematically.

Study summary

The evidence synthesis focused on evaluating the relationship between smartphone addiction and physical activity. Of the eight eligible studies, only two studies

met the criteria for good quality. Both studies evaluated the relationship between smartphone addiction and physical activity as the main research question in college students using convenience sampling. The first study used a self-reported measurement tool "Smartphone Addiction Scale for Adolescents (SAS-SV)"²³, and measured physical activity in 1519 vocational school students in Switzerland who asked participants about hours of participation in physical activity outside of school during the past 7 days. Multivariate model analysis ($R^2 = 0.05$) indicates a much higher smartphone addiction score when compared to a lower level of physical activity ($OR = 0.95$, $p < 0.02$). Research findings reveal that lower levels of physical activity are associated with a higher prevalence of smartphone addiction and stress in adolescents. Kim, et al²⁵ measured the level of physical activity through a Pedometer in terms of the number of steps and calorie consumption per day among 110 students. This study uses the "Smartphone Addiction Prone Scale"²⁵ for data collection. The results of the Kruskal-Wallis test analysis revealed that muscle mass was inversely related to smartphone addiction ($r = -0.245$, $p < 0.010$), and physical activity (walking steps) had a significant negative relationship ($r = -0.798$, $p < 0.001$) with smartphones addiction ($r = -0.578$, $p < .001$). It is the only study involving valid and reliable measurements of PA, and body composition using Pedometers and In-Body analyzers.

Two other studies^{26,28} a self-reported but valid but reliable self-reported smartphone addiction and physical activity assessment tool. For example, Gumusgul²⁶ investigated the effect of smartphone addiction on physical activity and recreational sports in 225 college students using SAS-SV. The results showed a significant difference between smartphone addiction and participation in recreational sports ($t = -2.57$, $p < 0.05$). The findings suggest that participation in recreational sports or physical activity may have a constraint for smartphone addiction. Venkatesh et al²⁸ evaluated the frequency of exercise that resulted in rapid breathing or sweating during the previous week among 205 dental students. Participants' smartphone addiction scores were measured via a self-reported tool (SAS-SV) and height or weight were evaluated via body mass index (BMI). The findings showed that higher smartphone addiction scores ($r = 0.985$, $p < 0.000$) were significantly associated with higher stress levels and BMI scores, and lower exercise levels. Alosaimi et al²⁷ used single-item questions that evaluated changes in practice levels before and after starting smartphone use among 2367 college students via the "Problematic Use of Mobile Phones (PUMP)" scale.

The study found that the smartphone addiction score ($r = 0.598$, $p < .000$) was positively correlated with decreased exercise and an unhealthy lifestyle among Saudi Arabian students, although the level of correlation with exercise was moderate. Of the

participants, 12.5 percent indicated that their exercise participation decreased compared to before starting smartphone use and 11.9 percent reported that they gained more weight as hours of smartphone use increased. SC et al²⁴ evaluated habits related to smartphone use and physical activity in 256 schoolchildren using the self-reported measures 'Brief Addiction to Smartphone Scale (BASS)' and 'Deprivation Sensations (DS)'. The results reported that higher smartphone use was significantly associated with lower levels of physical activity ($p < 0.042$). In addition, increased deprivation symptoms were associated with less exercise frequency ($p < 0.034$). Research findings suggest a healthy lifestyle for school children involves them in physical activity and sports.

The remaining two studies^{29,30} use online survey or interview technique to examine the relationship between smartphone use and physical activity. Leep et al²⁹ investigated smartphone use, physical activity and sedentary behavior, and their impact on physical fitness among 305 US university students. First, in an interview, the participants were asked about their smartphone use and physical activity behavior and then they completed a validated self-efficacy survey for exercise behavior. Treadmill tests were also conducted to measure the participants' cardiorespiratory fitness. The results showed a significant negative relationship between cell phone use and cardiorespiratory fitness ($\beta = 0.25$, $p < .047$), higher smartphone use significantly decreased physical activity and

increased sedentary behavior ($\chi^2 = 6.79$, $p < .009$). The study concluded that increased use of smartphones could reduce physical activity and impair cardiorespiratory fitness³⁰. compared smartphone use and physical activity between 242 US students and 194 Thai students in health disciplines using an online survey. The results showed that greater smartphone use was inversely related to lower physical activity among Thai students ($\chi^2 = 10.55$, $p < 0.01$) but not US students. Research findings suggest that increased use of smartphones may be a barrier to promoting physical activity in educational settings. On a final note, seven of the eight studies evaluated smartphone addiction scores using instruments that had good or moderate validity and reliability of SA and PA measures in the selected sample. However, a study loss of information about the validity or reliability of the tools used for data collection³⁰.

Association of Physical Activity with Smartphone Addiction

The review assessed the evidence regarding the association of sports participation and physical activity with smartphone addiction among a student population including all study designs, geographic locations, and gender. The current review consisted of eight cross-sectional studies of the existing research literature according to the specified inclusion and exclusion criteria. All articles selected in this review, were of good or fair methodological quality, consistently showing a negative relationship between physical activity and

smartphone addiction. Almost all the included studies support increased involvement of the student population in physical activity and sports. Because, being less involved in physical activity increases the likelihood of smartphone addiction in the student population^{23,25}. In particular, two studies also encourage participation in recreational sports or games in a school setting^{24,26}. In particular, the research included in this review shows a significant relationship between smartphone addiction and an unhealthy lifestyle²⁷, sedentary behavior²⁹, stress²³, higher body mass²⁸, higher fat mass and lower muscle mass²⁵. For the most part, the findings of these studies indicate that physical activity or sports and sports participation can help protect adolescents from developing smartphone addiction.

In line with the findings of the current review, previous research has also shown that high levels of physical activity are associated with lower rates of internet addiction³¹ and lower rates of cell phone addiction³². In addition, increased sports participation can significantly reduce internet addiction³³, and lower levels of game addiction in athletes compared to non-athletes³⁴.

Qualitative research studies do not fall into this topic, studies with larger sample sizes involving systematic sampling techniques are also absent. More importantly, no studies have presented the underlying mechanisms that explain the association of physical activity with smartphone addiction. Importantly, it is worth mentioning that this review is unique in that it

systematically identifies major gaps in this area of research regarding the relationship between physical activity and smartphone addiction. Future research should focus on addressing the gaps identified in our systematic review. No research has presented the underlying mechanism that explains the relationship between physical activity and smartphone addiction. Importantly, it is worth mentioning that this review is unique in that it systematically identifies major gaps in this area of research regarding the relationship between physical activity and smartphone addiction. Future research should focus on addressing the gaps identified in our systematic review. No research has presented the underlying mechanism that explains the relationship between physical activity and smartphone addiction. Importantly, it is worth mentioning that this review is unique in that it systematically identifies major gaps in this area of research regarding the relationship between physical activity and smartphone addiction. Future research should focus on addressing the gaps identified in our systematic review.

To advance empirical knowledge, longitudinal research and well-designed interventions are essential to address issues related to smartphone addiction and develop physical activity. Notably, each of the eight studies evaluated in this review used a cross-sectional design, and a causal relationship between physical activity and smartphone addiction could not be fully established based on their findings. Smartphone addiction is much higher in

adolescents and young adults studying in different educational settings; however, smartphone use behavior may vary at different stages of development. In this connection, longitudinal studies among adolescent students and children are essential for tracking behavioral changes at different ages and levels of study. Further, Longitudinal studies or interventions can help assess behaviors associated with smartphone use and physical activity over various time periods. Evaluating physical activity-related behavior and smartphone addiction at various time points may be more useful than being measured once in a cross-sectional study.

In addition, the research included in this review has several methodological problems. For example, there is only one study that uses an objective measuring instrument, namely the Pedometer. While determining physical activity through objective measurements such as pedometers, accelerometers, and heart rate monitors separately or in combination with self-reported measurements are believed to be more valid and reliable measurements that can help classify participants in various categories (high, moderate, low, sedentary) physical activity³⁵. This review suggests mandatory inclusion of such devices in future studies, separately or together with self-reported physical activity measures.

Although the research included in the current review demonstrates the effectiveness of exercise participation and physical activity as a barrier to smartphone addiction, however,

evidence regarding the mechanism of action underlying these effects is unknown. Of the selected studies, there is no study that addresses the issue of what factors are considered responsible for the relationship between smartphone addiction and physical activity. Participation in sports and physical activity has a variety of physical, social, biological, and psychological benefits. Thus, increasing sports participation or involvement in physical activity may have a beneficial effect on smartphone addiction through certain physical, psychological, or social improvements. Unfortunately, this issue also remains unresolved in the studies included in this review.

Previous studies have reported several psychological, physical, or social indicators related to smartphone addiction among adolescent students such as depression and anxiety³⁶⁻³⁸, loneliness and shame⁴, sleep disturbance^{1,39}, low level of self-esteem⁴⁰, and decreased self-control^{41,42}

Exercise and exercise-related intervention programs in educational settings may produce positive effects on these psychosocial factors which may further help prevent smartphone addiction among this population. Importantly, young people at high risk from these factors should be the main target of this intervention program. In this regard, school-based sports participation programs appear to be helpful in reducing anxiety and increasing self-esteem in school children⁴³. Also, university-based physical

activity programs can reduce depression and stress in college students⁴⁴.

Practical implementation as a solution to smartphone addiction and low physical activity due to smartphones

Based on the above discussion, the researcher suggests the following useful steps for educational institutions that can help prevent adolescent students from being addicted to smartphones, namely; 1). Students, particularly adolescents, in educational institutions should be screened thoroughly to identify subjects with serious psychological disorders associated with a higher risk of smartphone addiction (i.e., anxiety, and depression). 2). For students at high risk of addictive behavior, program-specific interventions such as physical activity and sports participation should be launched in close collaboration between psychologists, physical education teachers, sports coaches, and parents. 3). Rules and regulations regarding the use of smartphones in schools and universities need to be revised to control negative health outcomes. Restrictions or limited use of smartphones can be applied to students, especially those studying at school. 4). A comprehensive awareness campaign should be launched to promote physical activity among students targeting the negative outcomes of excessive smartphone use. 5). Physical education classes should be included regularly in the daily life of the school schedule which can help increase physical activity outside of school and during weekends. 6). Physical education teachers and sports coaches with relevant academic and

professional qualifications and experience need to be appointed in educational institutions to promote school-based physical activity. 7). Educational institutions must ensure adequate sports facilities along with sports equipment for students. 8). Finally, primary consideration should be given to rhythmic, recreational, and group-based exercise and exercise programs under the supervision of a sports therapist when using physical activity and exercise interventions for the treatment of smartphone addiction.

CONCLUSIONS

This review study concludes that physical activity and sports participation may have the potential to prevent smartphone addiction among adolescents. However, this study suggests rigorous and good-quality future research focusing on longitudinal, intervention, or cohort designs to confirm the findings of this review. Also, it should be noted that these findings can only be generalized to adolescents. Furthermore, the underlying mechanism regarding the positive effect of physical activity on smartphone addiction is still unknown. Thus, researchers working on behavioral addiction are encouraged to consider physical activity, exercise, or exercise for the prevention and treatment of smartphone addiction in the student population.

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