

A Preliminary Assessment of the Relationship Between Cellphone Use and Physical Activity, Sedentary Behavior, Anxiety, and Academic Performance in High School Students

Direct Original Research

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Abstract

Introduction: Prior research has examined the relationships between cellphone use and physical activity and sedentary behavior as well as measures of psychological well-being and academic performance. This work largely focuses on adults. However, there is an inverse relationship between cellphone use and age. Because their cellphone use may be different from adults, understanding these relationships in younger individuals is warranted.

Methods: High school students ($N = 17$) completed an online survey consisting of validated items assessing self-reported cellphone use, physical activity, sedentary behavior, anxiety, and grade point average. Correlation analyses were then performed assessing the relationships between cell phone use to all other variables.

Results: There were large, significant effect sizes ($r \geq -0.58$, $p \leq 0.04$) for negative correlations between cellphone use and vigorous and total physical activity. There was also a moderate effect size ($r = -0.39$; $r = 0.46$) for a negative relationship between cellphone use and mild physical activity and a positive correlation between cellphone use and anxiety, respectively. Cellphone use was not related to the remaining variables.

Conclusions: In this preliminary study of high school students, greater cellphone use was associated with greater anxiety, which supports prior research in adults. However, unlike research reporting a lack of a relationship in adults, greater cellphone use was associated with lower physical activity in high schoolers.

Key Words: GPA, smartphone, mental health, physical activity, exercise

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Introduction

Research has examined the relationships between cellphone use, physical activity, and sedentary behavior.¹⁻³ There is consistent evidence that greater cellphone use is associated with greater sedentary behavior.¹ However, the relationship between cellphone use and physical activity is unclear. Cellphone use has been linked with

decreased cardiovascular fitness yet multiple studies report no relationship between total cellphone use and physical activity when using self-reported measures.⁴ Conversely, assessing these variables with objective measures revealed significant, albeit small, inverse relationships.⁵ Obscuring matters further, certain cellphone functions (e.g., fitness apps) may promote physical activity while other functions (e.g., texting) commonly used during physical activity may interfere with activity intensity.^{6,7}

In addition to the potentially problematic relationships described above, greater cellphone use has been associated with greater anxiety and poorer academic performance.^{8,9} Much of this research relies upon college students and adults.¹ While there is some evidence indicating greater cellphone use is associated with greater anxiety and lower fitness in high school students these studies are fewer in number.^{10,11} This is potentially limiting as cellphone use is inversely associated with age.¹ Because cellphone use may be different in younger individuals, a better understanding of the relationships highlighted above is warranted in students below college age.

The purpose of this preliminary study was to assess the relationships between cellphone use, physical activity, sedentary behavior, anxiety, and academic performance in high school aged children. Considering prior research that assessed these relationships in adults, we hypothesized no relationship between total cellphone use and total physical activity and a positive relationship between cellphone use and sitting. We also hypothesized negative relationships between cellphone use and academic performance. Lastly, we hypothesized a positive relationship between cellphone use and anxiety.

Scientific Methods

Participants

High school students ($N = 17$, 16 ± 1.16 years old) in the Midwestern United States provided consent from their parent or legal guardian as well as individual assent and then completed an online survey assessing age, cellphone use (minutes/day), physical activity (score), sedentary behavior (sitting minutes/day), academic performance (GPA), and anxiety. An informative email was sent out from a high school administrator to all student's parents outlining the study as well as an opportunity for parents to give consent for their child's participation. A similar informative email seeking assent from potential participants was then sent to only high school students whose parents provided consent (Figure 1). All procedures were approved by the high school administrators as well as the university Institutional Review Board.

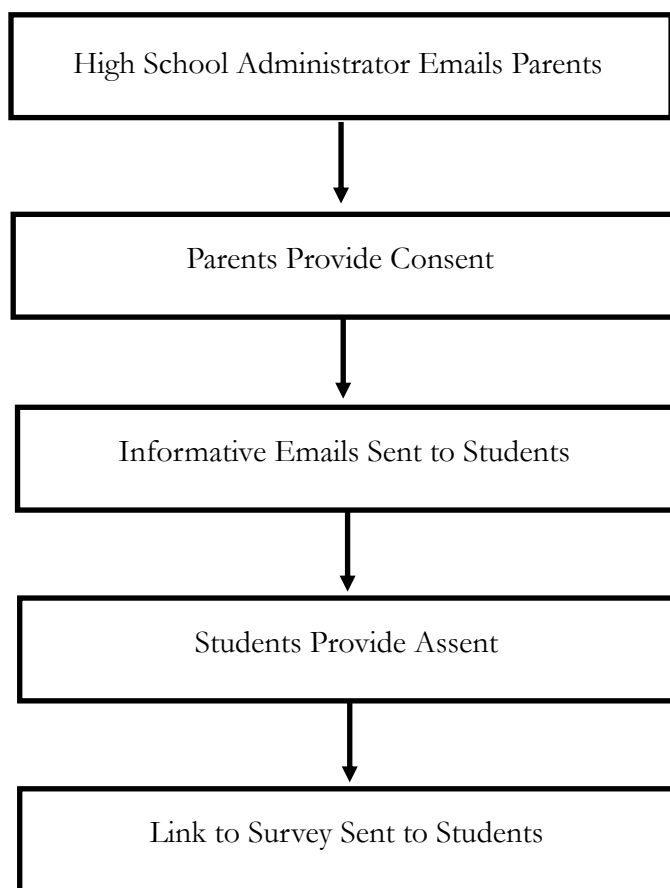


Figure 1. Schematic representation of the study procedures.

Protocol

Cellphone use was assessed by asking the following question:

“As accurately as possibly, please estimate the total amount of time you spend using your cellphone/smartphone each day. Please consider all uses *except* listening to music. For example: consider calling, texting, email, social networking (e.g., Snapchat, Instagram, Twitter, Facebook, etc.), sending photos, gaming, surfing the internet, watching videos, and all other uses driven by “apps” and software.”

Prior research has demonstrated that this method significantly predicts objectively measured cell phone use ($r = 0.43$, $p < 0.001$) with objective measures of cell and has been utilized in previous research.⁹ Physical activity was then assessed using the Godin Leisure-Time Exercise Questionnaire which significantly predicts objectively measured physical activity ($r = 0.46$, $p < 0.001$) and has evidence of good internal consistency (Cronbach's $\alpha = 0.85$).^{12,13} Participants reported average number of times they participated in strenuous, moderate, and mild physical activity for more than 15 minutes per day during a 7-day time frame. A total physical activity score was generated from those responses. Participants then reported their average daily sitting using the International Physical Activity Questionnaire which significantly predicts ($r \geq 0.34$, $p < 0.001$) objectively measured sedentary behavior (accelerometer counts of < 100 per minute) and has good test-retest reliability ($r \geq 0.77$).¹⁴ Participants self-reported GPA which according to a meta analyses from Kuncel et al. has strong associations to actual GPA ($r = 0.90$).¹⁵ Anxiety was assessed using the validated Beck Anxiety Inventory has good internal consistency (Cronbach's $\alpha = 0.92$) and test-retest reliability ($r = 0.75$).¹⁶

Statistical Analysis

Pearson correlations were used to assess the relationship between cellphone use, physical activity (mild, moderate, vigorous, and total, sedentary behavior, GPA, and anxiety. A-priori $\alpha \leq 0.05$ was considered statistically significant and all correlations were performed via SPSS Version 27 (IBM, New York). In this dataset there were some non-significant relationships that had a least medium effect sizes ($r \geq 0.30$). For those data points a power analysis (G*Power version 3.1.9.2) was used to determine the sample size that would be needed to achieve a significant relationship.¹⁷

Results

Table 1. Descriptive statistics for self-reported age, GPA, cellphone use, physical activity, sedentary behavior, and anxiety. Data are means $\pm$ SD and range.

Variable (self-reported)	Mean $\pm$ SD	Coefficient of Variation	Range (min to max)
Age (years)	16 $\pm$ 1.2	7.5%	14 – 18
GPA	3.9 $\pm$ 0.4	10.3%	3.3 – 4.6
Cellphone use (minutes)	321.9 $\pm$ 154.9	48.1%	0.0 – 546.0
Physical activity (scores)			
<i>Mild</i>	5.0 $\pm$ 2.3	46%	3.0 – 9.0
<i>Moderate</i>	25.4 $\pm$ 11.0	43.3%	10.0 – 40.0
<i>Vigorous</i>	48.8 $\pm$ 41.8	85.7%	0.0 – 162.0
<i>Total physical activity</i>	79.2 $\pm$ 47.4	59.9%	25.0 – 201.0
Sedentary behavior (minutes)	472.1 $\pm$ 167.4	35.5%	304.3 – 835.7
Anxiety (score)	42.1 $\pm$ 18.9	44.9%	21.0 – 82.0

Physical activity

There was a significant negative relationship between cellphone use and vigorous ($r = -0.61$, $p = 0.04$) and total physical activity ($r = -0.59$, $p = 0.04$). There was no significant ($r \leq -0.39$, $p \geq 0.21$) relationship between cellphone use and mild or moderate physical activity.

Sedentary Behavior

There was no significant ($r = 0.09$, $p = 0.79$) relationship between cellphone use and sedentary behavior.

Academic Performance

There was no significant ($r = -0.11$, $p = 0.71$) relationship between cellphone use and GPA.

Anxiety

There was no significant ($r = 0.46$, $p = 0.13$) relationship between cellphone use and anxiety.

Power Analysis

Power analyses were performed for all non-significant relationships that had medium to large effect sizes ($r \geq 0.30$) to determine the sample size needed to achieve a significant relationship (Table 2).

Table 2. Power analysis for non-significant $p \geq 0.05$ relationships that had medium to large effect sizes ($r \geq 0.30$). The effect sizes for each variable was used to determine the lowest possible sample size necessary to achieve significance ($p \leq 0.05$) with a power of 0.80.

Variable	Pearson Correlation	Sample Size Needed (achieve significance ($p \leq 0.05$) with 80% power)
Physical Activity <i>Mild Activity</i>	$r = -0.39$	$n \geq 79$
Anxiety Score	$r = 0.46$	$n \geq 55$

Discussion

While prior research from our group and others have assessed the relationships between cell phone use and physical activity, sedentary behavior, GPA, and anxiety in adults this is the first study we are aware of to assess these relationships in a sample of high school students.¹⁻⁹ The positive relationship between cellphone use and anxiety in high school students, while not significant, did yield an effect size that was nearly large. The notion that greater cellphone use is associated with greater anxiety is similar to prior research on adults at or above college age.¹⁰ While this finding was similar to prior research on adults the remaining results from the present study on high school students contain some differences. First, we did not observe a significant positive relationship between cellphone use and sedentary behavior. This is contrary to a positive relationship reported in research examining adults at or above college age.¹ Additionally, we observed significant negative relationships between cellphone use with vigorous and total physical activity. In other words, greater self-reported cellphone use was associated with lower participation in physical activity. This also differs from prior research from our group which has reported no such relationship in college-aged adults when using similar self-reported measures.⁶ However, the current results support findings of a similar negative relationship between self-reported cellphone use and physical activity in adults older than college age and a similar relationship in college students when utilizing objective measures of cellphone use and physical activity.⁵ In sum, these findings illustrate the equivocal findings regarding the relationship between cellphone use and physical activity. Because of these equivocal findings more research examining this relationship is warranted especially in younger populations.

Another differing finding was the lack of a relationship between cellphone use and GPA. Researching examining college students has reported a negative relationship between these variables.¹² In other words, college students that report greater cellphone use had lower GPAs. Respondents in the present study reported an average GPA of 3.9 with a range of 3.3 to 4.6 on a 4.0 scale. Because this sample consisted of high academic performers and a limited range of GPAs this may explain the present lack of a negative relationship between cellphone use and academic performance. These results may be different with a larger sample size and wider range of GPAs. This again highlights the need for further research examining correlates to cellphone use in high schoolers.

Limitations

While this study presents novel findings, it is not without limitations. The primary limitation being our small sample size consisting of students with high GPAs. The study was initiated shortly before the COVID-19 pandemic and once restrictions were implemented the response rate dropped to zero. Now that pandemic restrictions have been lifted, we recommend replicating a similar study with a larger sample size consisting of students with a larger range of academic performance. Another limitation was that they study only examined a sample of high school students. Given the present findings that differ from adults and the inverse relationship between age and cellphone use, it is warranted to extend this work to children younger than high school age. Finally, this study relied upon self-reported measures. Future research could utilize objective measures (e.g., activity trackers, actual GPA) to assess these variables.

Conclusions

In conclusion, we provided preliminary evidence of a significant inverse relationship between cellphone use and physical activity and no relationship between cellphone use and sedentary behavior or academic performance in high school students. These findings are somewhat different from research examining similar relationships in adults.¹ This



may be due to a previously reported inverse relationship between cellphone use and age. Future research with larger samples of high school students and younger children is warranted.

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