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The Relationship Between Cell Phone Use And Motivation To Exercise In College Students

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THE RELATIONSHIP BETWEEN CELL PHONE USE AND MOTIVATION TO EXERCISE IN COLLEGE STUDENTS

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This thesis, submitted by Ryan Doree in partial fulfillment of the requirements for the Degree of Master of Science Kinesiology from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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Table of Content

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ABSTRACT

Past research suggests that high cell phone usage is related to sedentary behavior, poor physical fitness, and poor mental health. College students cell phone usage has increased over previous years while physical activity levels have declined, but due to little research, this relationship is still unclear. The purpose of this study was to examine the relationship between college student's smartphone usage, exercise motivation, and physical activity. College students completed an electronic survey ($n=157$; female = 135; age = 20.01 ± 1.49; BMI = 24.39) that assessed exercise motivation, physical activity, smartphone usage, height and weight (to calculate BMI), depression, anxiety, stress and fear of missing out. Data was analyzed with Pearson correlation and independent t-tests using SPSS. Results showed that amotivation ($p < 0.01$) was positively associated with cell phone usage, while intrinsic motivation ($p < 0.01$) was negatively associated. High cell phone users ($M = 0.75 \pm 0.80$) showed greater amotivation for exercise than low-users ($M = 0.33 \pm 0.52$), while low-users showed higher levels of intrinsic motivation. This novel study suggests that cell phone usage may interfere with exercise motivation and could be a possible barrier for individuals trying to become more motivated to exercise. Future research should examine ways to limit cell phone use, increase motivation to exercise to improve overall quality of life.

1. Introduction

Over the past two decades, cellphones have evolved from being a device used for primarily voice calls to what we commonly refer to today as a "smartphone" with what seems like an endless amount of capabilities. Nearly 95 percent of Americans own a cell phone and of those 77 percent own a smartphone, which is up 35 percent from 2011 (Pew Research Center, 2018). The increased rate of smartphone ownership is spread across all demographic groups, but more young college-aged people living in urban areas own smartphones, as compared to older people living in a rural area, who are not in college (Pew Research Center, 2018). There is growing literature finding that many people overuse their phones in ways that can interfere with their daily life, commonly referred to as smartphone addiction or problematic smartphone use (PSU) (Elhai, Dvorak, Levine, & Hall, 2017; Cheever, Rosen, Carrier, & Chavez, 2014). Research indicates that high-frequency mobile phone use can lead to poor physical fitness (Lepp, Barkley, Sanders, Rebold, & Gates, 2013), and body composition (Kim, Kim, Jee, 2015), as well as signs and symptoms of mental health problems (Thomée, Härenstam, & Hagberg, 2011). The average smartphone usage by college students aged 18-29 has been reported to be five to six hours of use per day, while the most active users reported interacting with the device almost constantly (Lepp, Barkley, & Karpinksi, 2015). This is potentially worrisome because increased smartphone use may increase the likelihood of an individual becoming less physically active and more sedentary (Barkley, Lepp, & Salehi-Esfahani, 2015). Individuals who have a lifestyle with low physical activity and/or high amounts of sedentary activity have been seen to be associated with several adverse health outcomes (Biswas et al., 2015).

1.1 Problematic smartphone use

Today smartphones are capable of much of the same features that computers are capable of, and more due to its mobile capability. Smartphones allow users to stream movies, surf the internet, update social media, play games, video chat with someone across the world instantly, and complete many additional features by using specially designed software applications (apps) (Lepp, Barkley, & Li, 2016). In today's era of technological advances, most individuals own a smartphone, but those who are college-aged (ages 18-29) have the highest rate of ownership at an astonishing 94 percent (Pew Research Center, 2018). Smartphones are a regular part of people's days that nearly half of all smartphone users say that it is something "they could not live without" (Rainie & Perrin, 2017). That statement shows the level of importance a smartphone has in a user's life, but that attachment can become problematic.

Problematic smartphone use has been associated with both musculoskeletal and behavioral problems (Gustafson, Thomee, Ekman, & Hagberg, 2017; Thomee, Harenstam, & Hagberg 2011). A longitudinal study of young adults over five years looked at musculoskeletal disorders and smartphone use and found a strong association between high amounts of texting with neck/upper back and shoulder pain (Gustafson et al., 2017). Similarly, in a study involving a large population (n=4156) of young adults, linked high-frequency smartphone usage with symptoms of depression, sleep disturbances, and stress at a 1-year follow-up (Thomee et al., 2011). A recent systematic review looked at problematic smartphone use and found most of the literature on this topic to be supportive of the relationship between PSU to depression and anxiety (Elhai et al., 2017). A smartphone can impact a problematic users' day to day life to the point where users report having high anxiety levels are present from engaging with the phone (Lepp, Barkley, & Karprinski, 2014), and those levels can increase further when the smartphone is removed from them or usage is restricted (Sapacz, Rockman, & Clack, 2016; Cheever et al., 2014).

Compared to other age groups, college-aged individuals interact with their phone much more (Lepp et al., 2015). Because of the devices small structure, it makes the phone highly portable which gives the user the ability to engage with their phone almost anytime and anywhere. Previous studies have found that smartphones are commonly used in the workplace, in the classroom, while studying, during meals, and even while going to the bathroom (Harrison & Gilmore, 2012; Tindell & Bohlander, 2012). Furthermore, Harrison and Gilmore (2012) expand on that list after finding the devices are also at times used in the shower, during religious events, while having sex, and in other settings and circumstances in which it could be deemed inappropriate. The frequency in which college students engage with their phones has even been known to have a negative relationship with physical fitness (Lepp et al., 2013) and mental health (Lepp et al., 2015). It is essential for university students to be aware of the possible health risks from smartphone misuse.

1.2 Physical activity in college

Although efforts to promote physical activity have become a vital public health strategy for disease prevention (Bonevski, Guillaumier, Paul, & Walsh, 2013), there still seems to be a rapid decline of college-aged (18-24yrs) individuals from achieving physical activity recommendations (Plotnikoff, et al., 2015; Kwan, Cairney, Faulkner, & Pullenayegum, 2012). According to the American College Health Association-National College Health Assessment (ACHA-NCHA), undergraduate fall summary, 21.4 percent of students reported not achieving at least 30 minutes of moderate-intensity physical activity, while 40.5 percent reported not achieving at least 20 minutes of vigorous physical activity in the last seven days. Overall, only about 47.2 percent of college students are meeting recommendations for moderate-intensity exercise, vigorous-intensity exercise, or a combination of the two (ACHA, 2018).

1.3 Motivation

People are motivated by a number of experiences, consequences, and factors. Self-Determination Theory (SDT) examines motivation allowing researchers to make predictions regarding performance and psychological health outcomes (Deci & Ryan, 2000). For example, research has shown that intrinsic motivation is a crucial factor in exercise adherence leading to positive psychological feelings and reduced levels of stress (Wankel, 1993). According to the SDT, motivation ranges on a spectrum from amotivation to intrinsic motivation. Amotivation is simply being not motivated or having an intention to act (Deci & Ryan, 2000). In contrast to amotivation, there is intrinsic motivation. This refers to the genuine interest and inherent satisfaction of participating in the behavior itself (Deci & Ryan, 2000). When an individual's motivation to act relies on external reasons such as rewards, pressure, punishment this is referred to as extrinsic motivation (Deci & Ryan, 2000). Extrinsic motivation is separated into four groups to better define the various levels of motivation that lie between amotivation and intrinsic motivation (Deci & Ryan, 2000).

The four groups of extrinsic motivation are external regulation (external), introjected regulation (somewhat external), identified regulation (somewhat internal), integrated regulation (internal). External regulation refers to when an individual's behavior is controlled by a specific external occurrence(s), such as material reward or to avoid threatened punishment (Deci & Ryan, 2000). Introjected regulation is still somewhat external but differs from external regulation because the consequences are administered by themselves rather than an external source (Deci & Ryan, 2000). Identified regulation is defined as being slightly more internally than externally motivated such as when people begin to accept the underlying value of a behavior (Deci & Ryan, 2000). Lastly, there is Integrated regulation being almost entirely internally motivation; this is when people will have fully accepted a behavior and harmonized it with their other values and identity (Deci & Ryan, 2000). The SDT helps to assist in a better understanding of why college students are motivated to be physically active.

Regarding college students and motivation, it appears that communication and interaction with others is a heavy influence on their views of both PA and motivation (Fletcher, 2016). These interactions that directly impact motivation are predominantly external sources such as friends, family, and even from the media and environmental factors (Fletcher, 2016). This relationship is essential to note because Fletcher (2016) also found that college students may achieve enough PA in a week, but not regularly as a lifestyle choice due to these many barriers interfering with their exercise motivation. Proper interventions need to help to target overcoming these barriers as a means of shifting motivation.

1.4 Motivation and fear of missing out

Fear of missing out (FoMO) is a relatively new phenomenon, but it has already made a name for itself from being correlated with stress, depression, anxiety, and motivational factors (Przybylski, Murayama, Dehaan, & Gladwell 2013). FoMO is defined as a constant worry that others might be having rewarding experiences while you are gone and is characterized by the desire to stay continuously connected with what others are doing (Przybylski et al., 2013). It is usually developed or increased through PSU use or social smartphone use (Wolniewicz, Tiamiyu, Weeks, & Elhai, 2018). Social smartphone use refers to individuals that primarily use their phone for social purposes such as communication or social networking (van Deursen, Bolle, Hegner, & Kommers, 2015). Individuals with high levels of FoMO have been found to have less of these three critical motivational factors: competence (ability to do something successfully or efficiently), autonomy (violition), and relatedness (connectedness with others) (Przybylski et al., 2013). According to SDT, effective self-regulation and psychological health are based on the satisfaction of competence, autonomy, and relatedness. FoMO is directly related to motivation factors so it should be considered in today's ever-growing technological world when trying to promote PA.

1.5 Summary

A growing body of research is showing an association between smartphone usage to negative physical (Gustafson et al., 2017; S. Kim et al., 2015; Lepp et al., 2013) and psychological (Thomée, Härenstam, & Hagberg, 2011) health outcomes. With the increasing amount of smartphone users to date (Pew Research Center, 2018) as well as decreasing physical activity levels in college students (Plotnikoff et al., 2015; Kwan et al., 2012), it is crucial to understand this relationship fully, so we do not keep on this unhealthy trend. Therefore, the main focus of this study was to examine the relationship between college student's smartphone interaction (duration & problematic use), exercise motivation, and physical activity levels. It can be hypothesized that high-frequency smartphone users will be less autonomously motivated and less PA, whereas lower frequency users will be more autonomously motivated and more PA. With the rise in PA interventions using smartphone applications it is essential to understand that further increasing the number of interactions and time spent on smartphones could promote adverse effects for some individuals.

2. Method

2.1 Participants and Procedure

A volunteer sample (n=200) of university students from a large public university in the upper midwestern United States were recruited for this cross-sectional study. Inclusion criteria for this study were for participants to be a full-time student (undergraduate or graduate student), between the age of 18-29, and own a mobile phone. Researchers emailed the online survey link to university professors to share with their class. Included was information about the study rationale and why it was important. Additionally, researchers went to large general education classrooms, and students were able to volunteer to complete the survey in class. For classrooms that did not want the students to take the survey in class, they were given a piece of paper with the link to the online survey. The survey link was also on the university Facebook pages. Finally, fliers were placed around campus at high traffic areas to draw in more willing participants. All participants were informed of the general purpose of the study. This study was approved by the Institutional Review Board at the University of North Dakota.

2.2 Measures

2.2.1 Demographic Information

Participants self-reported sex, age, race, ethnicity, employment status, hours of work per week (if applicable), university major (open-ended), class status, weight and height (used to calculate body mass index.

2.2.2 Problematic smartphone use

The Smartphone Addiction Scale Short Version (SVS-SV) (Kwon, Kim, Cho, & Yang, 2013) looks at smartphone users usage to identify the level of risk for smartphone addiction but does not diagnose addiction. The SAS-SV consists of ten items rated on a six-point Likert-type scale, ranging from 1 (Strongly Disagree) to 6 (Strongly agree). Example items include "Having a hard time concentrating in class while doing assignments, or while working due to smartphone use", 'Having my smartphone in my mind even when I am not using it", and "Using my smartphone longer than I had intended". The higher the individual scores on this instrument indicate a higher risk of smartphone addiction. The SAS-SV has a strong internal consistency with a Cronbach's alpha coefficient of 0.91 (Kwon et al., 2013).

To measure the total daily smartphone use, the following question was asked: "As accurately as possible, please estimate the total amount of time (minutes) you spend using your mobile phone each day. Please consider all uses except listening to music. For example: consider calling, texting, sending photos, gaming, surfing, watching videos, Facebook, e-mail, and all other uses driven by "apps" and "software". This self-report measure has been used in previous research and was carefully developed to assure content validity (Lepp et al., 2015). Additionally, participants were asked to further describe mobile phone use preference by indicating what percent of time they spend using their phone to browse the internet, sending and receiving emails, text messages, making phone calls, video chatting, playing video games, engaging with social media (Snapchat, Facebook, Instagram, Twitter, YouTube, etc.), and all other uses driven by applications and software.

2.2.3 Motivation to Exercise

The Behavioural Regulation in Exercise Questionnaire (BREQ-3) is a 24-item questionnaire created to assess a participant's motivation to exercise (Markland & Tobin, 2004; Wilson, Rodgers, Loitz, & Scime, 2006). This instrument is a modification of the BREQ-2 which uses five subscales, but with the addition of the integration regulation subscale (Wilson et al., 2006). Responses to the questions are marked using a five-point Likert-type scale ranging from 0 (Strongly Disagree) to 4 (Strongly Agree) that measure 6 subscales: amotivation ("I don't see the point in exercising"), external regulation ("I exercise because other people say I should"), Introjected regulation ("I feel guilty when I don't exercise"), Identified regulation ("I value the benefits of exercise"), Integrated regulation ("I consider exercise part of my identity"), and intrinsic regulation ("I exercise because it's fun"). This instrument has demonstrated excellent alpha values of 0.82 for amotivation, 0.82 for external regulation, 0.76 for introjected regulation, 0.79 for identified regulation, 0.90 for integrated regulation, and 0.89 for intrinsic regulation (Berry, Rodgers, Markland, & Hall, 2016).

2.2.4 Physical Activity

The International Physical Activity Questionnaire (IPAQ-Short form) has been a widely used instrument for the measurement of total PA and SA (Craig et al., 2003). The IPAQ-Short form is also useful to quantify whether participants meet PA guidelines or not. There are 7 items used to record the activity of four intensity levels which are as followed: vigorous-intensity activity, moderate-intensity activity, walking, and sitting. Questions are answered based on a seven-day recall where participants indicated how many minutes and/or hours per day they were engaging in each activity, if applicable.

2.2.5 Depression, Anxiety, and Stress

Depression, anxiety, and stress were measured using the 21-item Depression Anxiety Stress Scale (DASS-21), a short version of the 42-item DASS (Lovibond & Lovibond, 1995). The DASS-21 measures distress along with the three subscales (depression, anxiety, & stress), but is not intended for clinical diagnosis. Each response includes a Likert-type rating from 0 = "Did not apply to me at all" to 3 = "Applied to me very much or most of the time". Each of the three subscales is scored independent of their group then categorized in levels of severity that are normal, mild, moderate, severe, and extremely severe. Adequate Cronbach's alpha scores have been reported as 0.85 (depression), 0.81 (anxiety), and 0.88 (stress) (Osman et al., 2012).

2.2.6 Fear of Missing Out

The Fear of Missing Out Scale (FoMOs) developed by Przybylski et al., (2013) aims to measure an individual's pervasive apprehension of missing out on experiences or learning about what others may be doing. This instrument uses a 10-item measure with a Likert scale ranging from 1 = "Not at all true of me" to 5 = "extremely true to me". Overall, this scale has demonstrated good internal consistency (a = .90) (Przybylski et al., 2013).

2.3 Data Analysis

The relationships between mobile phone use and motivation to exercise, PA, FoMO, DASS. Participants were split into two groups based on their mobile phone usage frequency (high and low), and independent t-tests were used to compare mobile phone use and motivation to exercise; FoMO, DASS, PA, and Sedentary Behavior.

3. Results

Participants characteristics are found in Table 1. A total of 200 students completed the survey. Forty-three participants were excluded due to: age being outside accepted range, non-full-time student, and incomplete responses to the survey items. Thus, the total sample size was 157 participants. The mean total daily smartphone use for the participants was 218.1 minutes per day (SD=±122.9). Participants in the study consisted of primarily females (86%) with an average age of 20 years (±1.5). Furthermore, females (225±127.3 min/day) averaged a higher daily phone usage when compared to males (174.1±80.2 min/day). All participants (100%) owned a mobile phone of any kind, and all (100%) owned a smartphone.

A Pearson correlation examined the relationship between phone use, motivation to exercise, PA, SA, FoMO, smartphone addiction risk and the DASS-21 (Table 4). Sedentary minutes per week ($r = 0.243$, $p = 0.002$), Amotivation ($r = 0.194$, $p = 0.015$), and smartphone addiction risk ($r = 0.239$, $p = 0.003$) were positively related to smartphone usage, while introjected regulation ($r = -0.239$, $p = 0.003$), identified regulation ($r = -0.285$, $p < 0.001$), integrated regulation ($r = -0.315$, $p < 0.001$), and intrinsic motivation ($r = -0.238$, $p = 0.003$) was negatively associated with smartphone usage. BMI ($r = 0.178$, $p = 0.026$), and external regulation ($r = 0.221$, $p = 0.005$) were positively associated with smartphone addiction risk score, while MET minutes per week ($r = -0.252$, $p < 0.001$) and intrinsic motivation ($r = -0.161$, $p = 0.045$) was negatively associated with smartphone addiction risk score. MET minutes per week was positively associated with introjected regulation ($r = 0.255$, $p < 0.001$), identified regulation ($r = 0.341$, $p < 0.001$), integrated regulation ($r = 0.477$, $p < 0.001$), and intrinsic motivation ($r = 0.323$, $p < 0.001$). MET minutes per week was negatively associated with amotivation ($r = -0.289$, $p < 0.001$).

Low and high cell phone usage levels were established by splitting participants into two groups based on median usage (180 min/day). The low usage group (n=77) included participants that used their phone for 180 minutes or less per day, and the high usage group was greater than 180 minutes per day (n=80). Independent samples t-tests were used to examine differences between high and low cell phone users when comparing exercise motivation, FOMO, depression, anxiety, stress, smartphone addiction risk, total weekly MET-minutes, total weekly sedentary minutes, and BMI (Table 2). Results showed there was a significant difference in amotivation mean scores for low (M = 0.33, SD = 0.52) and high (M = 0.75, SD = 0.80) conditions; $t(155) = -3.908$, $p < 0.01$. Meaning that greater than 180 minutes per day of cell phone use is associated with greater amotivation for exercise. Integrated regulation for exercise was significantly higher in the low (M = 2.56, SD = 1.00) compared to high (M = 1.77, SD = 0.87) cell phone users ($t(155) = 5.341$, $p < 0.01$). This result suggests that individuals who state using their phone for equal to or less than 180 minutes per day are more intrinsically motivated when it comes to exercise. Students that were categorized as a low phone user showed to have higher MET minutes (M = 3616.55, SD = 2813.59) compared to high cell phone users (M = 2597.46, SD = 1988.87; $t(155) = 2.629$, $p < 0.01$). Finally, low phone users had a lower BMI (M = 23.21, SD = 3.70) compared to high cell phone users (M = 25.53, SD = 6.07; $t(153) = 2.891$, $p < 0.01$).

Further independent sample t-tests compared mean values for types of cell phone usage for low and high users (Table 3). Mean values for amount of texting was shown to be higher for low phone users (M = 21.26, SD = 15.01) than high users (M = 15.99, SD = 10.93); $t(148) = 2.47$, $p < 0.05$. Mean values for amount of time spent on social media was lower for the low group (M = 35.1, SD = 18.70) compared to high group (M = 43.13, SD = 17.12); $t(147) = 2.74$, $p < 0.01$.

4. Discussion

This is the first study to examine the relationship between PA, smartphone use, and motivation to exercise. Furthermore, this study found a relationship between exercise motivation and smartphone usage. Researchers also found that high-frequency phone users had a higher BMI than those in the low-frequency group. High users engaged in more social media usage than the low users who tended to use their phones more for texting or exercise/ nutrition applications. These activities could help to explain the possibility as to why high users engaged in less PA than low users.

4.1 Exercise Motivation and PA

Previous research utilizing qualitative measures found that students are heavily motivated by what their peers are doing (Deliens, Deforche, Bourdeaudhuij, & Clays, 2015). For example, individuals from that study stated that if they do not have many friends who exercise then they will not be as motivated to exercise. Whether in person or through text message communication with peers is impactful to motivation, simply receiving a text message related to the individual's motivation needs has been shown to help promote PA behavior change (Kinnaflick, Thøgersen-Ntoumani, & Duda, 2016). Our study showed that the low cell phone users group participated in more texting compared to the high users. Kinnaflick and colleagues (2016) help explain this phenomenon and to help us to better understand why low-users reported texting significantly more than high-users and being more intrinsically motivated to exercise. For example, receiving messages that promote an individual's feeling of enjoyment for exercise or affiliation with peers that exercise can help to support autonomy, which is important for the growth of intrinsic motivation. The relationship between exercise motivation and PA provides good evidence that SDT helps demonstrate the importance of autonomous regulations in encouraging PA (Teixeira, Carraca, Markland, Silva, & Ryan, 2012). Integrated regulation is one of the strongest predictors of exercise duration across male and females (Duncan, Hall, Wilson, & Jenny, 2010). In our study, low users had a higher score for integrated regulation than the high users did. This might help to explain why the low users recorded engaging in more weekly PA than the high users, even though both groups managed to meet PA guidelines.

4.2 Smartphone Usage and PA

In our study, high and low smartphone users differed significantly in regard to METs per week. High users averaged much fewer METs per week than low users. Also, the high users reported engaging in more sedentary activity than the low users. Similar to our findings, previous research has found that smartphones may interfere with physical activity. Past research has shown similar to television screens, smartphones tended to be used as a leisure tool and were primarily done while sitting (Fennel, Barkley, & Lepp, 2019; Barkley & Lepp, 2016). Furthermore, Barkley and Lepp (2016) found that high-frequency usage individuals were more likely to use their device while exercising, which has been shown to reduce exercise intensity (Lepp et al., 2013). Our study did not find college students self-reported sedentary time to be significantly associated with smartphone use, however, more but high-users were overweight compared to low-users. low smartphone users were more likely to be considered normal weight. This difference in BMI could be could explained by many factors that promote weight gain during the transition to a more independent lifestyle in college such as alcohol drinking, unhealthy eating, lack of physical activity, and stress (Vadeboncoeur, Townsend, & Foster, 2015).

4.3 Smartphone Usage and Mental Health

This study supports previous research that examined phone use frequency and mental health. Previous research has also witnessed the relationship between phone use and having symptoms of depression, more specifically it has been stated that those who were categorized as a high user were more likely to express these symptoms (Thomée, Härenstam, & Hagberg, 2011). The low usage group reported having on average a lowered depression score than the high group, and they also reported engaging in more PA throughout the week. This outcome is supported with various research on PA and mental health, stating that PA correlates well with having a positive mood (Penedo & Dahn, 2005). On the other hand, individuals with depressive symptoms may rely on smartphones to alleviate negative emotions but unsuccessful, leading to a loop of depressive symptoms and more smartphone usage (Kim, Seo, & David, 2015). Additionally, those high-frequency users with greater depressive symptoms are more likely to exhibit PSU and use their smartphones for a more extended period during each session (Mitchell & Hussain, 2018). Similar findings in our research show that high-frequency users have higher depression and PSU scores compared to low-users. Mental health should not be overlooked when promoting PA because individuals that report having depressive symptoms also most often report lack of motivation, mood, and fatigue as barriers for exercising (Busch et al., 2017).

4.4 Strengths and Limitations

This study had several limitations. First, student PA was assessed with self-reported measures. Although the IPAQ-SF is a validated instrument to assess individuals weekly PA and sedentary behavior, individuals have been known to overestimate their MVPA (Shook et al., 2016). Second, all self-report measures were utilized for this study. This was the first study to examine smartphone use and motivation to exercise, thus, the use of self-report surveys are a great first step to exploring this novel relationship. Still, this study reveals insightful results that lead to further research opportunities. One of the strengths is that this was a novel study, building on what is previously known about exercise motivation. Findings from this study showed that individuals that their smartphone more frequently were less autonomously motivated to exercise than low-frequency users. This finding may have implications in future exercise interventions that utilize a smartphone to help individuals find more enjoyment and long-term adherence to PA. Additionally, a large sample size was used, allowing for a broad understanding of the relationship between smartphone use and motivation to exercise.

4.5 Conclusion

The results of the present study revealed that many factors are associated with college student's smartphone use throughout the day. Smartphones strongly influence what individuals feel and do, from increased depressive symptoms to decreased exercise intensity. Smartphones are becoming more common across this age group, and in this study all the participants owned a smartphone. Understanding motivators and barriers to PA is important to the development of effective interventions. While this is the first study to our knowledge that examines the association between smartphone usage, exercise motivation, and PA, future research should be conducted to explain this relationship further. Also, the use of objectively measured PA and sedentary behavior could help to prevent participants from possibly overestimating or underestimating their PA levels. The need for daily smartphone usage to have set values or cutoffs as to which an individual will begin to decrease in PA should be evaluated. A standard value could help to bring more reliable and consistent data together in the future. This study points out that smartphone usage may interfere with exercise motivation as it was shown correlate significantly with all areas of exercise motivation besides external regulation. This finding points out that smartphone usage should be considered as a possible barrier for some individuals trying to become more motivated to exercise.

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APENDIX

Table 1. Characteristics of the participant sample (n=157)

Gender[b]		
Male	22	14%
Female	135	86%
Age[a]	20.01	(1.497)
Race[b]		
White	142	90.4%
Non-white	15	9.6%
Ethnicity[b]		
Hispanic	4	2.5%
Non-Hispanic	153	97.5%
Own a mobile phone[b]		
Yes	157	100%
No	---	---
Own a smartphone[b]		
Yes	157	100%
No	---	---
Unlimited data[b]		
Yes	91	58%
No	66	42%
Body mass index[a] (BMI) (kg/m^2)	24.39	(5.66)
Underweight[b]	6	3.8%
Normal[b]	97	61.8%
Overweight[b]	33	21%
Obese[b]	19	12.1%
Missing[b]	2	1.3%

[a]*Mean values shown with SDs shown in parentheses.*
[b]*Number of students (n) are shown together with percentage value.*

Table 2: Independent sample t-test of high and low smartphone usage and types of usage.

	Low usage (≤180min cell phone use)		High usage (>180 min cell phone use)			
	n	*M (SD)*	*n*	*M (SD)*	*t*	*p*
BREQ	77		80			
Amotivation		**0.33 (0.52)**		**0.75 (0.80)**	**-3.908**	**<0.001**
External regulation		1.44 (0.95)		1.49 (0.91)	-0.351	0.726
Introjected regulation		**2.69 (1.05)**		**2.37 (0.81)**	**2.163**	**0.032**
Identified regulation		**3.32 (0.62)**		**2.79 (0.70)**	**5.062**	**<0.001**
Integrated regulation		**2.56 (1.00)**		**1.77 (0.87)**	**5.341**	**<0.001**
Intrinsic motivation		**2.91 (0.88)**		**2.36 (0.99)**	**3.638**	**<0.001**
DASS	74		78			
Anxiety		5.54 (6.13)		6.90 (6.96)	-1.273	0.205
Stress		9.35 (8.34)		10.97 (7.84)	-1.237	0.218
Depression		**7.11 (8.16)**		**10.15 (10.44)**	**-1.996**	**0.048**
SAS-SV	**77**	**27.94 (8.97)**	**80**	**30.93 (8.48)**	**-2.147**	**0.033**
FOMO	72	2.16 (0.77)	74	2.31 (0.98)	-1.031	0.305
Total MET minutes/wk	**77**	**3616.55 (2813.59)**	**80**	**2597.46 (1988.87)**	**2.629**	**0.009**
Sedentary minutes/wk	76	381.58 (141.38)	78	420.38 (174.56)	-1.514	0.132
BMI	**76**	**23.21 (3.70)**	**79**	**25.53 (6.07)**	**-2.891**	**0.005**

Table 3: Independent samples t-test of high and low smartphone usage and types of usage

	Low Usage		High Usage			
	n	*M (SD)*	*n*	*M (SD)*	*t*	*p*
Browsing the internet	62	12.84 (9.19)	62	11.37 (9.65)	0.87	0.387
Email	65	9.28 (7.42)	66	7.56 (6.29)	1.43	0.155
Texting	**72**	**21.26 (15.01)**	**78**	**15.99 (10.93)**	**2.47**	**0.014**
Making voice calls	53	9.23 (6.68)	49	7.41 (6.73)	1.37	0.174
Taking photos or videos	42	7.52 (5.42)	48	8.58 (7.95)	0.73	0.468
Watching videos	53	17.85 (15.23)	61	16.51 (10.71)	0.54	0.593
Playing games	22	9.82 (9.57)	28	12.11 (9.81)	0.83	0.412
Social media	**72**	**35.1 (18.70)**	**77**	**43.13 (17.12)**	**2.74**	**0.007**
Exercise or Nutrition apps	**21**	**11.14 (14.30)**	**11**	**4.27 (2.90)**	**2.12**	**0.045**
Other	4	10.5 (3.11)	3	20 (23.43)	0.70	0.556

*Bolded indicates statistically significant at $p<0.05$

Table 4: pearson correlation matrix table

Variables	1	2	3	4	5	6	7	8	9	10
1. MPU time	-									
2. SAS-SV score	.239**	-								
3. METs per week	-.131	-.252**	-							
4. Amotivation	.194*	.077	-.289**	-						
5. External regulation	-.021	.221**	-.028	.170*	-					
6. Introjected regulation	-.239**	.053	.255**	-.300**	.190*	-				
7. Identified regulation	-.285**	-.121	.341**	-.607**	-.160*	.471**	-			
8. Integrated regulation	-.315**	-.131	.477**	-.540**	-.121	.494**	.772**	-		
9. Intrinsic motivation	-.238**	-.161*	.323**	-.592**	-.302**	.375**	.774**	.732**	-	
10. Sedentary minutes	.243**	.066	-.135	.119	.058	-.074	-.095	-.183*	-.153	-
11. BMI	.112	.178*	-.06	.086	.170*	.09	-.121	-.152	.09	.93

*$p < .05$.
**$p < .01$.