A Pilot Study to Examine the Impact of Smartphone Screen Time and Self-Reported Exercise in the Physically Active Adults

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by

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Abstract

Previous research has shown more screentime to be associated with lower physical activity. Screen devices, such as smartphones, have become commonly used by individuals during exercise given their multi-entertainment functions. While it is well established that declines in physical activity can be contributed to increase screentime, it is unclear as to the impact of smartphone screentime has on exercise behavior. This study seeks to examine how screentime impacts minutes of self-reported physical activity during an exercise session among physically active adults. Four participants were asked to record minutes of screentime, minutes of moderate-to-vigorous-physical activity (MVPA), and duration of exercise sessions over a 7-day period. All data collected used self-report survey pre-and post-exercise. Participants would also indicate the primary smartphone function utilized during each session (i.e. listening to music, talking/texting, video entertainment). Through the data collected, it was determined that there were no significant differences between average screentime and average minutes of MVPA. Furthermore, this study did not find a correlation between screentime and physical activity. A major contribution to these results could be the small sample size of participants included in the study. Future recommendations for this research would be to include a larger sample to provided definitive results. Additionally, objective measurements, such as accelerometers, should be utilized to measure MVPA given that self-report instruments may be inaccurate or overestimated based on time displacement.

Introduction

Over the past two decades, the revolutionary development in smartphone technology has adapted such devices to become a social norm within today's society. While the commercial benefits of smartphone devices are well known smartphones have been contributed to the increasing amount of screentime across the general population with the evolution of technology (Fountaine et al., 2011; LeBlanc et al., 2017; Oraison et al., 2020; Vizcaino et al., 2019). Screen time has continued to increase which can become a contributing factor which distracts individuals from daily tasks. According to the Center for Disease Control and Prevention (CDC), 80.2% of children aged 12-17 reported spending over 2 hours on their phone a day (CDC, 2020). Previous literature has examined how screentime is impactful on general behaviors, mental health, and academic performance (Demirci, Akgönül, & Akpinar, 2015; Oraison et al., 2020). However, while the screentime literature has shown continued interest, there are limited studies that have examined screentime and implications associated with healthy lifestyle behaviors such as physical activity. Additionally, while the association between screentime and sedentary behavior has been examined, there are few studies that have examined the impact of smartphone screentime may have on exercise behaviors (Fountaine et al., 2011).

Exercise, or physical activity, behavior has been shown to have significant health benefits when individuals are participating in adequate amounts of time. However, smartphone usage during exercise may increase the amount of screentime while simultaneously decreasing the amount of physical activity time. The purpose of this study is to examine whether smartphone screen time replaces a person's minutes of MVPA during structured exercise.

Screen Time

While exact definitions of 'screen time' vary, it is generally understood as the time spent engaging in sedentary activity due to use of electronic devices; including computers, televisions, mobile devices, and more (Aust et al., 2019). Over the past thirty years, the advancements in technology across various platforms has evolved to become an essential tool within today's social norm (LeBlanc et al., 2017). One of the most utilized devices within today's society is a smartphone mobile device. A smartphone is a cellular device that has multiple capabilities, allowing the user to communicate, receive information, and entertain themselves seamlessly (Demirci, Akgönül, & Akpinar, 2015). In other words, a smartphone is able to function much like a computer, but is more portable (Amez & Baert, 2020). The use of smartphones allows users to access any information in an instant and is easy to use when a person has spare time and Oraison et al. reported that participants were satisfied by the 'instant gratification' aspect of their smartphones (2020).

As of 2021, 85% of Americans own a smartphone and 15% of Americans depend on their smartphone as their sole form of internet access (Pew Research Center, 2021). Smartphone users can even become 'addicted,' where their lives are being impacted by their overuse of this technology (Demirci, Akgönül, & Akpinar, 2015). Of adults aged 18-29 years old, 48% reported that they are 'almost constantly' online which shows the degree of which smartphones have taken over (Atske & Perrin, 2021). Quality of sleep, mental health, and physical fitness have all been found to have negative associations with smartphone use (Amez & Baert, 2020). As smartphones are more often associated with entertainment, they can be an easy distraction from school or daily activities which can impact prevalence of exercise (Amez & Baert, 2020; Barkley & Lepp, 2016a; LeBlanc et al., 2017).

Due to the enhancement of such devices, screen time has now become a health concern with established recommendations provided by government organizations. The CDC currently has established guidelines for total screen time recommendations and alternative activities for age groups under 18 years old. Even with these established guidelines, reports show that youth between the ages of 15-18 spend around 7 ½ hours using screen-based entertainment a day. However, what is lacking is recommendations and statistics for adults (CDC, 2018).

One of the most significant issues associated with screentime is the increase in sedentary behaviors which has been linked to metabolic disease. In addition to associations with chronic diseases due to sedentary behavior, copious screen time is also associated with a decline in mental health (LeBlanc et al., 2017; Ruegsegger & Booth, 2018). When an individual's attentional focus is occupied by common devices, such as smartphone usage, their ability to focus on primary tasks decreases due to these distractions (Amez & Baert, 2020; Rebold et al., 2015). The benefits of screen time are highly contextual and rarely outweigh the negative aspects when considering its relationship with sedentary activity (LeBlanc et al., 2017).

Previous studies have used various approaches to measure screen time on a daily or weekly basis primarily using objective measurement tools or self-recall methods (Davies et al., 2012; Ernala et al., 2020; Oraison et al., 2020; Vizcaino et al., 2019). A study by Hodes & Thomas (2021) used the iOS feature on Apple products that allows users to get an objective measure of their total screen time. This study found that participants overestimated their average time spent on their screen based on the data provided by the iOS screen time tracker. However, another feature on iOS products allows users to examine how much battery life they use on various applications for the previous 10 days. When viewing this data, researchers found that participants would underestimate how much time they spent on various applications (Hodes & Thomas, 2021).

Exercise and PA

Exercise is commonly used to as an intervention to improve cardiorespiratory fitness and improve overall body composition (Foulds et al., 2014; Vina et al., 2012). Exercise helps reduce the risk of developing type 2 diabetes and has preventative effects with other metabolic disorders, bone and joint diseases, cancer, and cardiovascular diseases and even small doses of physical activity can provide minimal health benefits (Schoenborn & Stommel, 2011; Vina et al., 2012). There are even cognitive and emotional benefits associated with exercise that contribute to a person's overall well-being. Regarding mental health, exercise helps to promote growth and development in the brain while helping to reduce symptoms associated to depression (Hogan et al., 2013; Ruegsegger & Booth, 2018). Although there are many well-known benefits to exercise, accumulation of time spent in being sedentary is still very common among adult populations (Ruegsegger & Booth, 2018). The increasing amount of daily screen time among adults also leads to an increase in sedentary activity. This could be indicative of a potential negative impact on time spent exercising at moderate intensity during structured exercise (Mansoubi et al., 2014). A study that examined participants' walking speed as they used a smartphone reported an inverse relationship between smart phone use and cardiorespiratory fitness which could be due to sedentary behavior (Barkley & Lepp, 2016b). The displacement hypothesis suggests that the more time a person spends viewing a screen replaces the time a person would spend doing physical activity (Fountaine et al., 2011; Maibach, 2007). With this hypothesis, most studies have examined how screentime affects children, with very little studying the adult population (Maibach, 2007). While previous studies have reported to not find a significant association between this hypothesis and BMI, this does not discount the negative effects of sedentarism (Cleland et al., 2018; Maibach, 2007).

According to the Physical Activity Guidelines for Americans (PAGA), physical activity recommendations for adults suggests participating in 150-300 minutes of moderate-intensity aerobic physical activity or 75-150 minutes of vigorous-intensity aerobic physical activity per week. In addition to aerobic activity, adults should also incorporate resistance training at least two days a week for all the major muscle groups (PAGA, 2018).While the health benefits of physical activity are well established, many US adults continue to not meet these recommendations (Schoenborn & Stommel, 2011). A survey examined physical activity data from adults was collected from 1997-2004 and obtained from the National Health Interview Survey (NHIS). Of all the participants, only 15.7% met both the strength and aerobic physical guidelines from 2008. Of the sample of 242,397 eligible US adults, 45.9% presented with at least one chronic disease. Additionally, adults that were diagnosed with at least one type of chronic disease were more likely to neglect meeting the PAGA recommendations (Schoenborn & Stommel, 2011). Similar findings were reported in an earlier study which examined data from the National Health and Nutrition Examination Survey (NHANES). The most recent data from 2018 found that only 24% of American adults were meeting the both the aerobic and strength guidelines from the 2008 PAGA (CDC, 2018)

A longitudinal study conducted by Omura and colleagues (2021) collected data over the course of 30 years (1998-2018) in increments of 3-year spans. Researchers recruited civilians throughout the US and their aerobic PA and chronic health conditions were evaluated to determine if individuals were eligible. Every 3 years, the research team recruited new participants for the study. Of the data from 2016-2018, 55.9% of those aged 18-34 presented with diabetes and 55.7% had hypertension (Omura et al., 2021). However, research shows both these disorders can potentially be prevented by exercise (Schoenborn & Stommel, 2011). This study found that in general, those who presented with a health condition also neglected to consistently meet the minimum level of aerobic PA outlined in the PAGA (Omura et al., 2021). The benefits of physical activity have been well established in the literature and continues to be studied. Thus, the concern with screen time is that it may increase sedentarism, which then decreases physical activity. However, there are some people that choose to use their phone *while* exercising according to a study conducted in Seoul, South Korea. Some participants reported that they purposefully used their phone in the gym as a distraction to divert their attention away from exercise and how much effort it was requiring (Patel & O'Kane, 2015).

Self-Report Physical Activity

A common method for measurements of physical activity is self-report instruments. Physical activity recall tools are often utilized in research when measuring both quantitative and qualitative variables of targeted behavior. Although self-report physical activity recall is easily accessible and user-friendly, the accuracy of these types of instruments tends to be questioned in comparison to accelerometry; which is the prefer method for measuring minutes of physical activity movement. In a study conducted by Tucker, Welk, & Beyler (2011) compared data from self-reported measures of physical activity versus accelerometer data from 2005-2006. According to accelerometry data, less than 10% of US adults met physical activity recommendations. However, it should be noted that participants significantly overestimated their levels of activity variables ranging from 59.6% to 65.7% (Tucker, Welk, & Beyler, 2011).

Self-report surveys, although cost effective, have many limitations including inaccurate reporting by study participants for several reasons. Self-recall methods may be unreliable in some contexts because participants could have disorders or bias that may impair their sense of time. While it would be desirable for participants to self-report *and* provide objective electronic data, it can often be costly and can require additional expertise (Ernala et al., 2020).

Methods

Participants

Participants were recruited via word of mouth and poster advertisement placed around the Ohio Dominican University campus. During the recruitment process, participants completed an initial recruitment survey to determine eligibility for the present study. Informed consent was obtained through the initial recruitment survey where participants were also considered eligible for the study or not. To be considered for the study, individuals had to comply with following criteria:

1. Be between the ages of 18-35
2. Have a personal smartphone device
3. Considered physically active; completing $\geq$ 3 exercise sessions at a commercial gym over the past 4 weeks,
4. Willing to complete pre/post workout surveys as part of the study
5. A member of the ODU community
6. Not a current collegiate athlete

Measures

Time Duration of Exercise Session

Participants reported the current time of day in the pre-workout survey then once again in the post-workout survey. The difference between these was recorded as the total time the participant spent in the gym.

Self-reported Minutes of Screentime

Participants reported total minutes of ‘screentime’ based on the values reported from their personal smartphone settings. The survey asked participants to report their screen time upon starting and ending their workout by going into the settings of their smartphone and going to the section titled ‘Screen Time.’ The differences between the total minutes of screentime were calculated based on values from the beginning and the end of each workout. The total screentime was then compared to their overall time spent in their exercise session.

Self-Reported Minutes of Physical Activity

Participants filled out the same survey as the beginning at the end of their workout with additional questions that inquired about their type of workout and their perceived amount of time spent doing moderate-intensity exercise. Their total perceived minutes spent doing MVPA was compared to their total time spent at the gym and their measured screen time.

Use of Smartphone Device during Exercise

Participants self-reported the primary function(s) utilized by their smartphone device at the conclusion of each exercise session. This was an indication of which functions contributed to the majority of their screentime while they were exercising. These functional options listed include “listening to music”, “reading”, “video entertainment”, “texting/talking”, and “social media viewing”. Participants would select “other” if none of the above functions applied.

Strength Training vs Endurance Training During Exercise Session

Participants self-reported the category of exercise was completed for most of their current exercise session. These categories included “strength training” (resistance exercise) or “endurance training” (cardiovascular exercise).

Procedure

After completing the recruitment survey and consent, a member of the research team contacted the participant(s) to schedule a study introduction meeting. During the introduction meeting, a member of the research team explained the study protocol. Participants were provided instructions of how to complete a self-report survey which was asked to be completed before and after each workout session. Over the next 7-day period, participants were asked to continue their own habitual exercise regimen with at least three sessions completed on separate days. Before and after each workout session, participants were asked to complete the self-report surveys. A unique identification number was entered at the beginning of the survey in order to keep any data collected anonymous. This was sent to them via email along with an explanation of the instructions for reference. For the pre-exercise survey, participants had to indicate the current time of day and report their current screentime for the day (in minutes; this is found in the

'Settings' portion of a smartphone). For the post-exercise survey, participants were asked the same questions, but also had to indicate whether they did primarily strength or endurance training, what they used their cellphone for during their workout, and how much time (in minutes) they perceived that spent doing MVPA during their workout.

Additionally, participants were asked to complete each workout session with a minimum timeframe of at least 60 minutes (i.e. 2:00pm – 3:00pm; 7:00am – 8:20am). After the 7-day period, participants were considered finished with their participation. No follow-up meeting was required after the conclusion of the study. The responses provided from each participant were collected into a dataset for future analysis. The experimenters analyzed the self-reported data from each participant by examining the average minutes of screen time and minutes of MVPA.

Results

A total of 7 participants completed the recruitment survey. Following the initial recruitment, a total of 4 participants were included in this study. Table 1 reflects the age and gender of participants in the study.

Table 1. Demographic Description of the Sample (n=4)

Demographic Variables	**Age (yrs)**
Participants (*n=4)*	20.6 ± 1.5
Gender	
Male (n=2)	18.5 ± 0.7
Female (n=2)	21.0 ± 0.0

While statistical power was not met, statistical analyses were done to examine the data in several domains. Gender differences were examined for descriptive purpose. Table 2 includes descriptive data for exercise variables and screen time for each subject. Participants were asked to record a minimum of three separate exercise sessions with data collected before and after each session. Figure 1 depicts the average minutes of exercise sessions, minutes of MVPA, and minutes of screen time per session. From the descriptive data, there was a significant difference in self-reported minutes of MVPA and minutes of screen time. However, when comparing these variables with the data from subject ODU-003, minutes of screen time was only 8.75 minutes less than accumulated minutes of MVPA. Additionally, a correlation analysis found self-reported minute of MVPA, and total screen time were not correlated ($p > 0.05$).

Table 2. Average Minutes of Self-Report Exercise Variables and Screen Time

Subject ID	Minutes per Exercise Session	Minutes of MVPA	Minutes of Screen Time
ODU-001 (n=3)	182.67 ± 13.61	106.67 ± 5.77	9.00 ± 1.00
ODU-002 (n=4)	65.75 ± 11.00	45.00 ± 7.07	19.50 ± 5.20
ODU-003 (n=4)	73.75 ± 19.92	42.50 ± 13.23	33.75 ± 14.20
ODU-004 (n=3)	80.00 ± 15.52	40.00 ± 8.66	16.00 ± 3.61
Total Sample	*96.14 ± 49.11*	*56.43 ± 28.52*	*20.57 ± 12.02*

Figure 1 presents the variables listed in Table 2 for a visual representation of minutes per exercise session, minutes of screen time, and minutes of MVPA across all four participants.

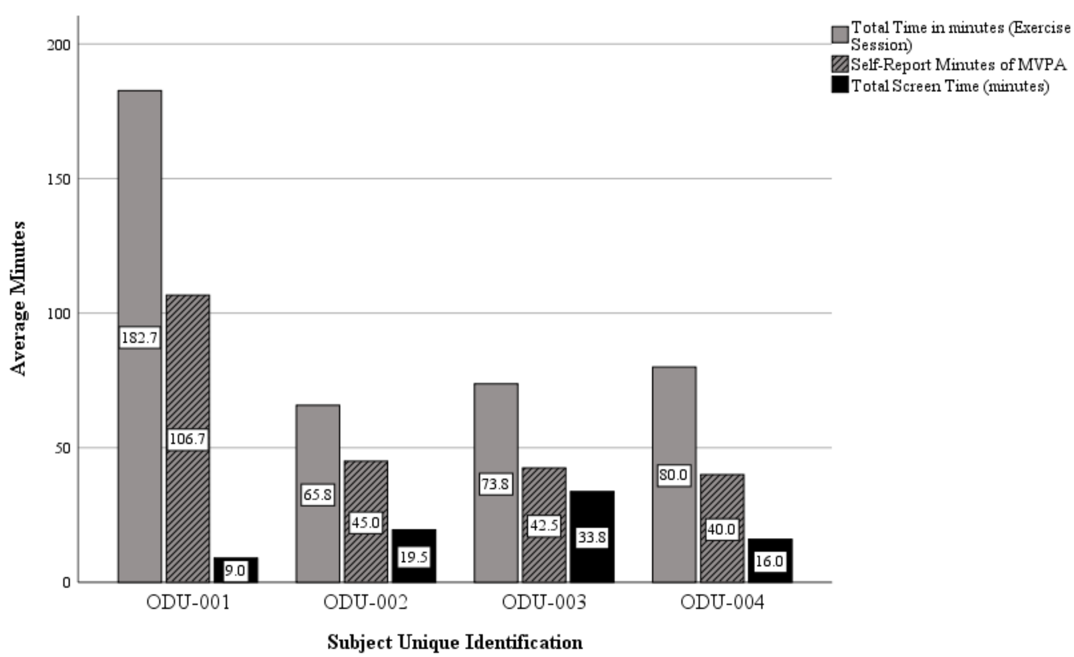

Figure 1. *Bar Chart of Participants Average Minutes for Exercise sessions, Screen Time and Self-reported MVPA.*

Independent sample t-test were used to compare gender differences between self-report minutes of MVPA and total minutes of screen time. This analysis concluded a significant difference for minutes of MVPA with male participants report higher rates of activity compared to females ($p < 0.05$) (Figure 2).

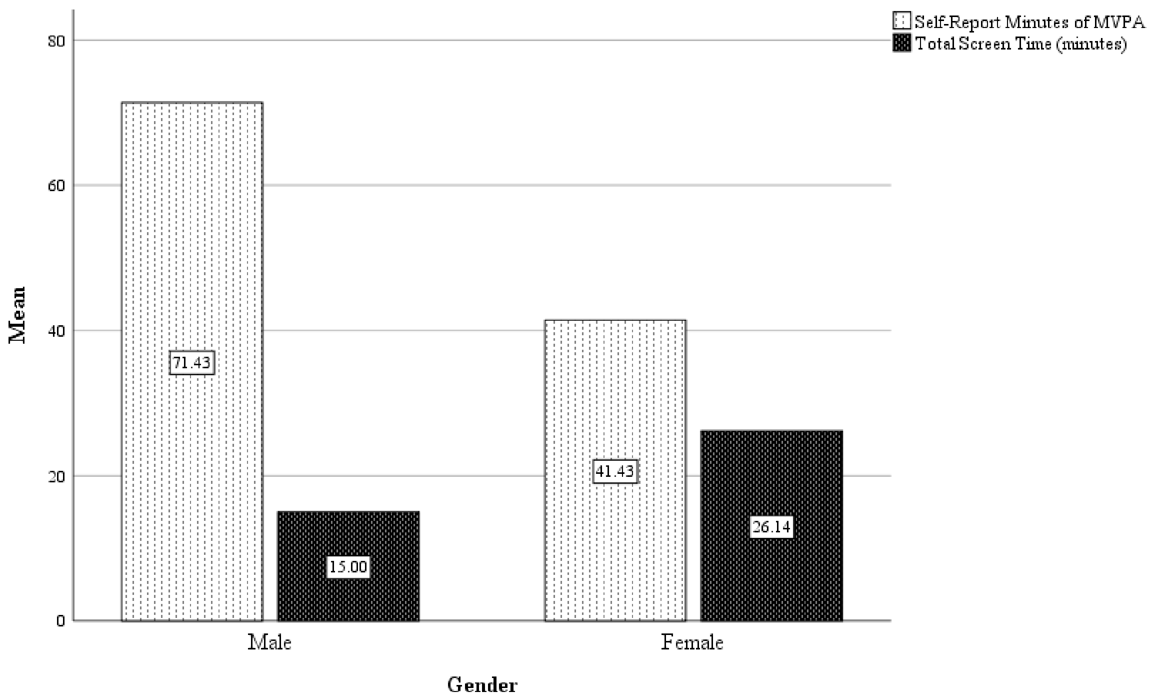

Figure 2. *Gender Differences for Self-Reported MVPA and Total Screen Time*

Figure 3 shows the type of exercise each subject reported they did for a *majority* of their workout. Based on this figure, it appears participants did more endurance than strength training during their workout.

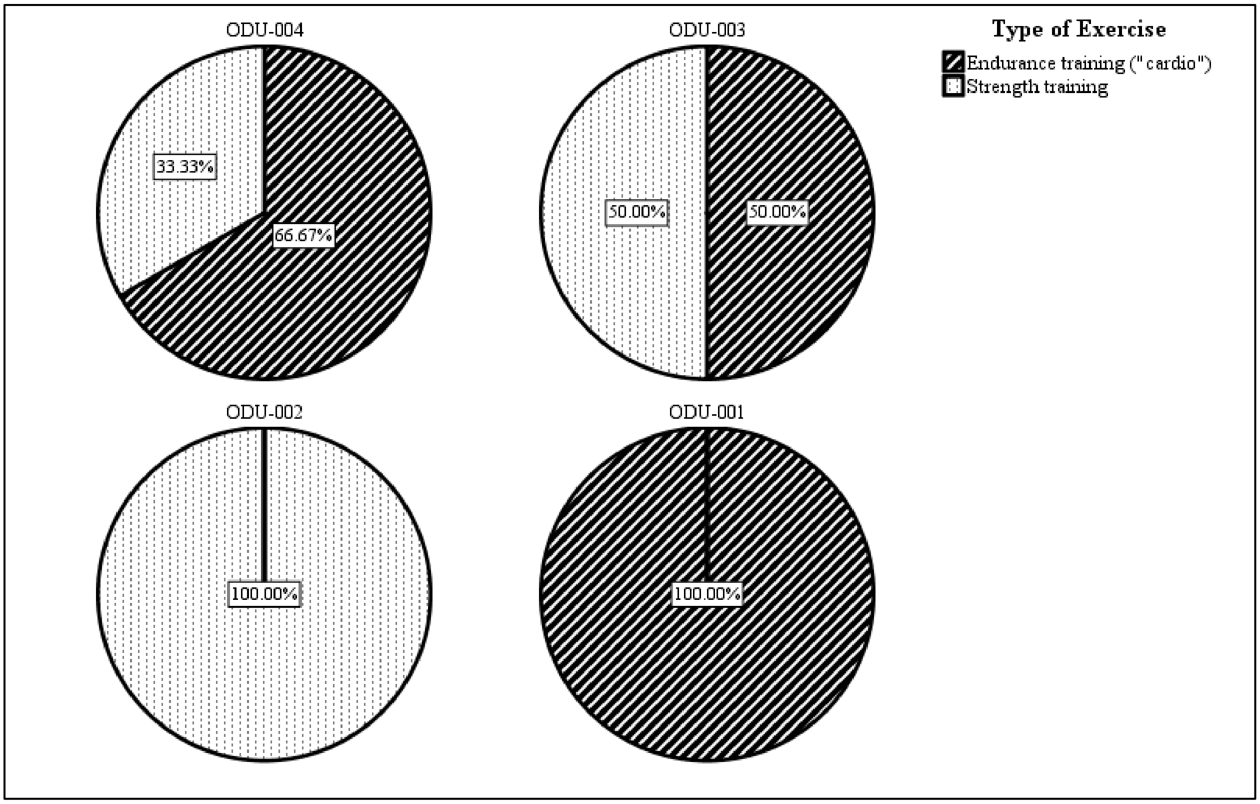

Figure 3. *Percentage of Exercise Category Reported by Participants per Exercise Session.*

Figure 4 represents descriptive data of participants reporting primary usage of smartphone during the length of their workout. Most of the smartphone usage primarily included listening to music throughout their workout in addition to multiple functions. However, subjects also reported using their smartphone for texting/talking during each workout.

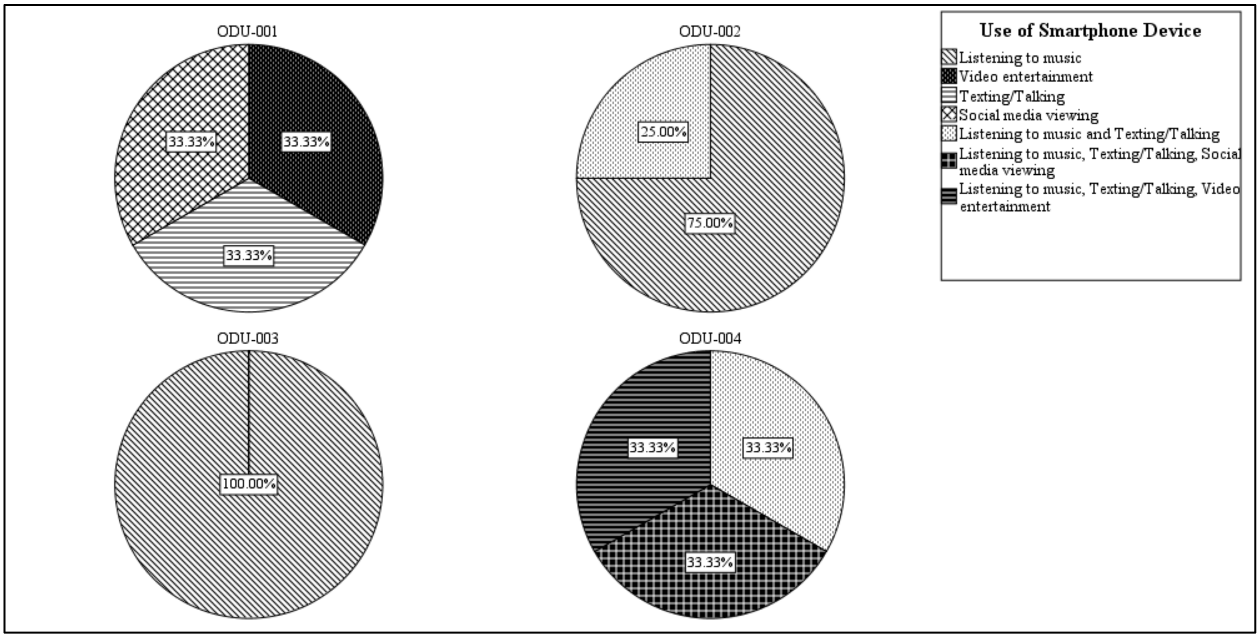

Figure 4. *Percentage Category of Smartphone Device Usage for Participants.*

Discussion

The purpose of this study was to examine the relationship between smart phone screen time and whether it impacted levels of MVPA within exercise sessions. Our goal was to determine if the displacement hypothesis was applicable during structured exercise sessions by reporting screen time and self-report minutes of MVPA. Our findings from this study suggest that smartphone screentime did not directly impact minutes of MVPA during structured exercise sessions among physically active adults. However, it is worth noting that a contributing factor to this outcome is in part due to the small sample size for the given study. Previous research by Rebold and colleagues had participants walk on a treadmill under various conditions – control, music, texting, and talking. Findings from this research showed that treadmill speed was lower for the 'texting' and 'talking' conditions, suggesting that participation in mobile phone usage during exercise can decrease exercise workload (Rebold et al., 2015). Another study conducted by Barkley & Lepp (2016a) showed that, among college students who reported ‘high’ cell phone use (average 765 min/day), only 18.8% reported using their phone during moderate level exercise.

Smartphone use during exercise is a highly prevalent topic of discussion with limited research that has been conducted thus far. To our knowledge, no studies to date have examined the displacement hypothesis specifically during structured exercise sessions. Additionally, to our knowledge, there are no studies that provided definitive evidence which indicates screen time directly replaces time dedicated to MVPA during planned and structured physical activity. Due to the lack of data collected in this study, it is suggested to examine further to better understand the displacement hypothesis in future behavior research. Additionally, it is worth mentioning that while our study examined total time of exercise sessions and self-reported minutes of MVPA, all participants were meeting the recommended activity levels for the week based on PAGA guidelines for adult populations. However, the findings from the self-reported instrumentation may be misleading as we did not use objective measurements to accurately represent minutes of MVPA. Further consideration should be given to utilizing quantitative measurements of physical activity and intensity levels when examining minutes of MVPA.

Despite the uniquity of this study, there were many limitations that contribute to future directions in this study area. This study included a small sample with only four participants who completed the protocol. Therefore, sufficient statistical power would not be acquired for the results to be definitive. Additionally, the sample for this study was not diversified with all participants identified as white/Caucasian. All study participants were students, although adults aged 18-35 who had an affiliation with the university were also eligible for recruitment. Thus, there could be no comparison of screentime or perceived MVPA for students, faculty, and staff.

In addition, a further limitation to this study was that the data recorded (MVPA and screentime) was only done during exercise. Had these variables been measured consistently over a 7-day period, we could have observed a possible link between the two. As these things were only measured during exercise, only 3-4 days of data for their exercise was measured. Ideally, it would be more beneficial if we could record 7 days' worth of data as it could have provided more conclusive results.

In the future, it may be beneficial to do a comparison study where some participants have access to their phones during exercise while others have no access. In addition, the use of accelerometers could be beneficial in providing a direct objective measure of the participants' time spent doing MVPA throughout their exercise session. Since participants were asked to report their perceived minutes of MVPA, there could have been multiple factors that impacted their perception due to the nature of the study. Many people tend to define MVPA differently based on their experience and exercise regimen. As we did not use a Rate of Perceived Exertion (RPE) scale, participants were expected to report their MVPA based on their own understanding of it. Additionally, participants could have subtracted their screen time from their total minutes spent doing an exercise session and reported this as their minutes of MVPA due to their knowledge of the study.

Although being in a commercial gym setting and self-report measures contributed to the uniquity of the study, there would be benefits to replicating this study in a lab-based environment. Furthermore, a comparison study would be impactful to compare the use of smartphone versus non smartphone presence during exercise sessions. However, there are also limitations to being in a controlled environment with subjects becoming aware of behaviors being assessed, which could alter their habitual behavior patterns. Additionally, in a funded exercise lab, there may be access to accelerometers and the researchers could provide objective measures of the subjects. Accelerometers are the gold standard when it comes to measuring physical activity and the levels of which someone is being active at. Even other fitness monitors, such as smartwatches, could provide additional physiological variables such as heart rate and breathing rate. Although, using commercial devices in research to measure these variables should be used with caution as many devices have not been established as valid and reliable instruments.

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