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Exploring Preschooler Mobile Media Use and Relationships with Physical Activity, Executive Functioning, and Sleep

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Exploring Preschooler Mobile Media Use and Relationships with Physical Activity, Executive Functioning, and Sleep

by

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Abstract

This study investigated the exposure to and use of screen devices in preschool children (3-5 years old) and whether mobile media use related to executive functions, physical activity, and sleep. A total of 32 mothers from Southern Alberta completed online questionnaires that measured their child's media exposure, mobile media use, executive function behaviors (e.g. attention, emotional control), physical activity, and sleep habits. Preschooler's executive functioning was assessed with A Development Neuropsychological Assessment – Second Edition (NEPSY-II). Results indicated that children are meeting screen time recommendations set by the Canadian Pediatric Society (2017), spending an average of 34 minutes a day on any screen device. Television and mobile devices were the most commonly used. Children who used mobile media daily had significantly better ratings of emotional control compared to children who did not use mobile media daily. Sleep did not significantly moderate the relationship between mobile media use and executive functioning or physical activity outcomes. Interpretations of these findings, along with implications, limitations, and future directions are provided.

Keywords: Screen Time, Mobile Media, Preschool Children, Executive Functioning, Physical Activity, Sleep

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CHAPTER 1

INTRODUCTION

The impact of screen time on child development has been, and continues to be, a topic of significant debate, speculation, and inquiry for parents, educators, and researchers. For more than half a century, children have been exposed to rapidly evolving technology. In the 1950's and 1960's, researchers explored only a few screen devices, including television (TV), radio, print, and movies (Lyle & Hoffman, 1972; Steiner, 1963). In the 1980's, screen devices broadened to include cable TV, satellite, VCR, videogames, and computers (Dorr & Kunkel, 1990). Now in the 21st century, children have unprecedented access to numerous screen devices, including mobile media devices, which refer to portable screen devices such as tablets, smartphones, iPods, and the use of applications (apps; Paudel, Leavy, & Jancey, 2016; Rideout, 2017).

The availability, mobility, and excitement in using mobile media devices have made them very popular to children and families (Paudel et al., 2016); however, the American Academy of Pediatrics (2016) and the Canadian Pediatric Society (2017) recommend limiting screen time to less than one hour per day for children ages 2-5 years old. This recommendation stems from both the empirically supported and speculated cognitive, behavioral, and health implications of excessive screen use by young children (The American Academy of Pediatrics, 2016). For example, excessive TV exposure has been linked to sleep disturbances, language delays, and poorer executive functioning in early childhood (Cespedes et al., 2014; Lillard & Peterson, 2011; Wu et al., 2016). Further, excessive screen time limits the amount of physical activity in children, contributing to a greater body mass index (BMI) and lower cardiovascular fitness (Hancox, Milne, & Poulton, 2004). Such effects appear to be best explained by the displacement hypothesis, which posits that time spent engaging in screen viewing replaces time engaging in

health-promoting activities that assist healthy childhood development (Anderson, Huston, Schmitt, Linebarger, & Wright, 2001).

The majority of the existing literature on screen time and child development, however, is primarily focused on traditional screen sources, including TV and video consoles, and the research findings are generally inconsistent. For example, some researchers have found that educational and interactive TV programs and computer use can aid literacy, behavior, and cognition in young children (Anderson et al., 2001; Christakis et al., 2013; Rosenqvist, Lahti-Nuuttila, Holdnack, Kemp, & Laasonen, 2016), while others have found that fast-paced and excessive TV viewing is related to lower executive function performances (Lillard & Peterson, 2011; Rosenqvist et al., 2016). Moreover, a considerable amount of research has reported that excessive TV viewing negatively impacts sleep duration and sleep quality, contributes to a later bedtime, and increases daytime sleepiness in preschool and school-aged children (Brockmann et al., 2016; Brunborg et al., 2011; Cespedes et al., 2014; Nuutinen, Ray, & Roos, 2013; Seguin & Klimek, 2016). Little is published, however, about how mobile media devices are related to executive functioning, physical activity, and sleep habits in preschool children.

Research exploring the impact of mobile media devices on child development is needed because the experience of using a mobile media device (e.g., smartphone) is qualitatively different than watching TV or using a computer (Menkes, 2012). Unlike traditional screen sources, mobile devices have multiple forms of activities and demand active participation and interaction (Menkes, 2012). A study conducted by Daluz and Mapoy (2011) found that, among first grade students, those who were presented with a computer-based story from an audio-visual presentation (similar to TV viewing) remembered the story better than those who experienced the story from the interactive participant condition (i.e., using the computer mouse to play games

while watching the story). Additionally, the touch-screen option of mobile media devices eliminates the need for hand-eye coordination needed to use a computer mouse or play a video game console, and the visual designs and sound effects of mobile devices may be distracting children from educational content (Menkes, 2012). Not to mention, the portability of mobile devices permit children to use mobile media devices for short bursts throughout the day and during daily routines, such as riding in the car or eating in the restaurant, potentially taking away the opportunity for children to learn from their environment or exercise executive function skills such as attention control (Nathanson & Beyens, 2018).

Given this background, research on mobile media use is needed in addition to the ongoing research on traditional screen sources, given that extant research is lacking and inconclusive and thus necessitates further examination. The purpose of the present study is to examine the relationship among early mobile media use, executive functioning, physical activity, and sleep habits in preschool children (3-5 years old). Early childhood is a critical time period where health behaviors, such as physical activity, are formed (Schmutz et al., 2017). Therefore, encouraging health behaviors and discouraging sedentary time (i.e., screen use) at this age may help increase the chance that children carry over healthy habits into later stages of life (Schmutz et al., 2017). Of note, the goal of this research is not to focus on only the negative consequences of preschoolers' screen viewing activities, but rather it is exploratory and intends to understand how children's early exposure to mobile devices may be related to select areas of their learning and wellbeing. As stated by Savina, Mills, Atwood, and Cha (2017), "digital media itself is not dangerous for young people; however, its impact depends on when, how much, and to which contents children are exposed" (p. 86). Thus, the purpose of this research is to contribute to a

growing body of literature that will inform parents and educators on both the positive and negative ways that the use of mobile media relates to early childhood development.

CHAPTER 2

REVIEW OF THE LITERATURE

Mobile media devices have become a pervasive element of Western culture, with young children given ample access to smartphones, laptops, and tablets (Kabali et al., 2015; Rideout, 2017). Although mobile media devices can create opportunities for learning and promote social interactions, excessive use may interfere with important aspects of child development (i.e., executive functioning and sleep) and replace health-promoting activities, including physical activity (American Academy of Pediatrics, 2016). Therefore, it is important to understand how much time young children are spending using mobile media devices and how this relates to and possibly impacts different aspects of child development (i.e. executive functioning, sleep, and physical activity).

The following literature review begins by examining the research related to how much time children are spending using mobile media devices and what type of mobile devices they using most commonly. Next, literature pertaining to various outcome variables will be explored, namely physical activity, cognitive development (e.g., executive functioning), and sleep. Physical activity is an important factor influencing healthy childhood development and growth (Lindsay, Greaney, Wallington, Mesa, & Salas, 2017). Thus, research examining the importance of physical activity on health outcomes, the extent to which preschool children and meeting physical activity guidelines, and how it may be related to screen viewing will be reviewed. Secondly, cognitive areas of functioning for preschool children may also be impacted by early mobile media use, and one such area that will be explored in the current study is executive functioning. In particular, executive functioning is defined as interrelated high-level cognitive processes that are responsible for formulating, planning, and facilitating goal-directed behaviors

(Anderson, 2002; Anderson, & Reidy, 2012; Nilsen, Huyder, McAuley, & Liebermann, 2017). Included in the following literature review is further conceptualization of executive functioning, the neurological development of executive functions in preschool children, and how it may be related to screen viewing. Lastly, sleep is another critical component of healthy childhood development that may be influenced by mobile media use. Research on how sleep is related to physical activity and executive functioning will be provided, and it will be explored on its own and as a potential moderating variable in the current research study. This chapter will then conclude with an overview of the current study, including study objectives and research questions.

Mobile Media Use in Preschool Children

The development and popularity of mobile media devices is noticeably evolving. Evidence of this is shown from three national representative parent surveys conducted by Common Sense Media regarding screen use in over 1000 American children ages 0-8 years old (Rideout, 2011; 2013; & 2017). The aggregate results of these surveys showed that over the last 7 years, children aged 0-8 years continue to have greater access to mobile media sources and are using mobile devices more frequently and for longer durations (Rideout, 2011; 2013; & 2017). Specifically, 52% of children had access to a mobile device in their home in 2011, which increased to 75% in 2013, and finally 98% in 2017 (Rideout, 2011; 2013; & 2017). Moreover, 8% of the children surveyed used these devices daily 2011, which doubled to 17% in 2011, and again increased to 28% in 2017 (Rideout, 2011; 2013; & 2017). However, TV remained the most dominant screen device that children viewed, taking up 72% of all screen time, while time spent using mobile media devices tripled each year (Rideout, 2011; 2013; & 2017).

Overall, the Common Sense Media studies revealed that children's total daily amount of time on any screen device was under two hours in 2013 (1:55 minutes), but over two hours in both 2011 (2:16) and 2017 (2:19; Rideout, 2011; 2013; & 2017). Of that time, 69 minutes were spent watching TV, 31 minutes watching DVDs, 17 minutes on computers, 14 minutes on video games, and 5 minutes using mobile devices in 2011 (Rideout, 2011). In 2013, 57 minutes were spent watching TV, 22 minutes watching DVDs, 11 minutes using computers, 10 minutes playing video games, and 15 minutes using mobile devices (Rideout, 2013). Lastly, in 2017, 58 minutes were spent watching TV, 17 minutes watching DVDs, 10 minutes using a computer, 6 minutes playing video games, and 48 minutes using mobile devices. On mobile devices, the majority of time was spent watching videos and playing mobile games (Rideout, 2017).

A cross-sectional study of 350 children from ages 6 months to 4 years was conducted by Kabali and colleagues (2015). They found that by age 4, 75% of children owned their own mobile media device and spent an average of 109 minutes per day watching TV, playing video games, using apps, and watching videos. Moreover Xu, Wen, Hardy, and Rissel (2016) conducted a longitudinal study following 667 pregnant Australian women for five years during and after their pregnancy, and found that when the children were 2 years old, they spent an average of 1.37 hours a day using any screen device, which increased to 2.48 hours/day at age 3.5, and 2.25 hours/day at age 5.

Taken together, findings from these studies indicated that mobile media devices have evolved to become a significant source of total screen time for young children, and that in most cases, total screen time use is exceeding pediatric and physical development recommendations. The Canadian Pediatric Society (2017) recommends that children aged 3-4 years should not exceed more than one hour of total screen time, and children aged 5 years old should limit screen

time to less than two hours per day. These recommendations are similar to the policy statement released by the American Academy of Pediatrics (American Academy of Pediatrics, 2016) that advises parents to limit screen time to one hour or less per day of high-quality programming for children older than 2 years old. These recommendations were put in place due to the growing amount of evidence suggesting that screen time may be related to less physical activity, cognitive delays, and sleep impairments in young children (American Academy of Pediatrics, 2016).

Physical Activity

The importance of physical activity for young children's' development is well documented in the literature. Physical activity in early years is vital for many areas of physical development, including bone and skeletal health, strength, endurance, and the growth of enhanced skills and movements (Venetsanou, Kambas, & Giannakidou, 2015). Additionally, a literature review conducted by Timmons, Naylor, and Pfeiffer (2007) found evidence to support a positive association between physical activity and weight, bone and skeletal health, motor skill development, psychosocial health (e.g., social competence and externalizing behaviors), and cardio metabolic health (e.g., cholesterol) in preschool children.

It is commonly reported, however, that children are becoming less active and more sedentary at earlier ages (Colley et al., 2011; Rideout, 2017; Tremblay et al., 2017). Looking at physical activity trends from the ParticipACTION report cards, 84% of 3-4 year-old children met the physical activity guidelines in 2014, which dropped to 70% in 2015 and 2016. Alarmingly, these percentages dramatically decrease as children get older, and overall, Canadian children have a long history of failing physical activity recommendations (Active Healthy Kids Canada, 2014; ParticipACTION, 2015; 2016). Implicating the rise of technology and screen use in

children's' lives for this decline in physical activity, however, remains speculative. Physical activity guidelines for Canadian children are reported in Appendix A.

Investigating the claims that preschool children may be more sedentary and inactive, Chaput et al. (2017) conducted a study to determine if preschool-aged children are meeting the new 24-hour movement recommendations. Using a Canadian population of 803 preschool children aged 3-4 years old, 61.6% met the new physical activity recommendations, while only 24.4% met the aforementioned screen time recommendations of less than 1 hour per day. Similarly, Australia adopted the same 24-hour movement recommendations, and Cliff et al. (2017) found that 93.1% of preschool children met the physical activity guidelines, while only 17.3% met the screen time recommendations of less than 1 hour per day. Overall, 16.9% of children met both the physical activity and screen time recommendations, suggesting that there may be evidence mounting for concerns regarding the connection between preschool children's viewing activities and their corresponding rates of physical activity.

Screen Time and Physical Activity. Excessive screen time may be a potential factor contributing to inactivity in young children. For instance, some researchers have found that preschoolers who spend more time engaging in screen viewing activities spend less time being physically active (Marshall et al., 2004; Schmutz et al., 2017; Tanaka et al., 2017). For example, Dawson, Fesinmeyer, and Mendoza (2015) found that greater TV viewing was positively associated with lower amounts of physical activity in Latino preschool children. Likewise, several researchers have found that promoting physical activity in preschool children results in lower screen time (Downing et al., 2016; Gray et al., 2015).

Although time engaged in sedentary behaviors inevitably replaces time engaged in physical activity, several researchers have found that screen time is not consistently associated

with less physical activity (Marshall et al., 2004; Melkevik, Torsheim, Iannotti, & Wold, 2010; Rey-Lopez, Vicente-Rodriquez, Biosca, & Moreno, 2008;). Lindsay et al. (2017) conducted a systematic review on the early influences on physical activity in preschool children and found that there are many different factors contributing to inactivity in young children. Of note, they found consistent research noting that gender, parental education, attending childcare centers, and family structures can influence physical activity in preschool children. Taken together, there is a considerable amount of research that shows screen time may influence physical activity in early childhood, although the majority of research that does exist focuses only on traditional screen devices, and there are many other influencing factors to consider that make it difficult to posit any causal connections between screen time and outcomes like physical activity.

Executive Functioning in Preschool Children

In the past decade, researchers and educators have explored the importance of executive functioning in many areas of early childhood development (Baggetta & Alexander, 2016). Indeed, the development of executive functions in preschool years is predictive of later academic, social, emotional, and behavioral functioning (Anderson & Reidy, 2012; Nilsen et al., 2017). Researchers have also found that executive functioning in preschool predicts math achievement and teacher-rated academic functioning at grade 3 (Bull, Espy, & Wiebe, 2008; Sasser, Beirman, & Heinrichs, 2015) as well as attention problems in later childhood and adolescence (Pauli-Pott & Becker, 2011; Schoemaker et al., 2011; Skogan et al., 2015). Although executive functioning plays a critical role on a child's academic, social-emotional, and behavioral development, Isquith, Crawford, Espy, and Giolia (2005) reported that given the multiple conceptualizations and components that make up executive functioning, the construct is largely misunderstood, possibly contributing to less study in preschool children.

Definitions and Models of Executive Functioning. There are a variety of different definitions, frameworks, and functions that complicate the conceptualization of executive functioning, especially when one wishes to operationalize the construct for research. Baggetta and Alexander (2016) conducted a systematic review of the conceptualization and operationalization of executive functioning to help bring clarity to the construct. They found that researchers often conceptualize executive functioning as a set of multidimensional cognitive processes that 1) guide actions and behaviors for learning and performing tasks, 2) monitor and regulates actions, and 3) relate to social-emotional and behavioral functioning (Baggetta & Alexander, 2016). The definition used in the present research study similarly conceptualizes executive functioning as interrelated high-level cognitive processes that are responsible for formulating, planning, and facilitating goal-directed behaviors (Anderson 2002; Anderson & Reidy, 2012). That is, the purpose of executive functioning is to organize and direct cognitive activity, emotional responses, and behavior (Gioia et al., 2003).

The components that make up executive functioning vary by different models (Baggetta & Alexander, 2016). This research identifies the key components of executive functions as: a) sustained attention, b) inhibition and self-regulation, c) initiation of activity, d) working memory, e) mental flexibility and utilization of feedback, f) planning ability and organization, g) selection of efficient problem-solving strategies, and h) monitoring of performance, all of which are critical for learning, social, emotional, and behavioral functioning (Anderson 2002; Anderson & Reidy, 2012). Correspondingly, one popular model of executive functioning proposed by Miyake and colleagues (2000) identifies inhibition, working memory, and mental shifting as the core executive functions (Anderson & Reidy, 2012; Baggetta & Alexander, 2016). Inhibition refers to the ability to deliberately inhibit responses and stop behaviors at the appropriate time (Gioia,

Andrews, & Isquith, 2003). Additionally, working memory refers to the holding and encoding of relevant information in the brain (Miyake et al., 2000), and mental shifting, which is sometimes described as cognitive flexibility, refers to as the ability to switch between multiple tasks or mental sets (Diamond, 2013; Gioia et al., 2003).

Similarly, a model proposed by Diamond (2006) views the same core executive functions as mental shifting, inhibition, and working memory, but also posits that these core functions work together to construct higher order executive functions such as reasoning, problem solving, and planning (Baggetta & Alexander, 2016). Planning refers to an individual's ability anticipate future events, set goals, and develop steps to reach goals (Gioia et al., 2003). Diamonds model also posits that these executive functions help one to regulate thoughts, actions, and attention (Baggetta & Alexander, 2016). As such, the construct of emotional control, referring the ability to control emotional responses (Gioia et al., 2003), is recognized as an outcome of executive functioning rather than an underlying ability (Baggetta & Alexander, 2016). Overall, the models proposed by Miyake et al. (2000) and Diamond (2006) address the components of executive functioning used in the current research: Working memory, mental shifting, inhibition, emotional control, and planning/organizing. Additionally, there is a growing body of research indicating that these aforementioned executive functions begin to develop in early childhood, and thus, are included in the current research study as an outcome that might be correlated with mobile media use.

Development of Executive Functions. Compared to the historical assertions that executive functions do not develop until adolescence, it is now well established that these higher-order processes begin to emerge much earlier in life (Anderson & Reidy, 2012). Indeed, the prefrontal cortex is largely responsible for executive processes, and although this brain region

does not reach full maturity until adolescence/young adulthood, there is a rapid growth in the anterior region during early childhood (Anderson & Reidy, 2012). In fact, some executive functions begin to emerge as early as infancy (e.g., working memory; Diamond, 1995), and by the age of 3 years old, children are reasonability skilled in inhibitory control, working memory, and mental shifting (Anderson & Reidy, 2012; Carlson, 2005; Diamond, 2013). As a result of brain development and social experiences, there is rapid growth in preschoolers' executive function abilities from ages 3-5 years old (Carlson, 2005).

As mentioned above, working memory begins to develop in infancy and matures drastically in the preschool years (Diamond, 1995). Indeed, in the preschool years, children are capable of completing spatial self-ordered working memory tasks (Anderson & Reidy, 2012; Hongwanishkul, Happaney, Lee, & Zelazo, 2010). In regards to inhibition, preschool children tend to have an immature inhibition mechanism, as indicated by their performance on executive functioning tasks and behavioral responses (e.g., waiting in line, taking turns; Carlson, 2005; Diamond, 2013; Zelazo et al., 2003). However, with maturation of the dorsolateral prefrontal cortex in later preschool years, there is significant development of inhibitory control from ages 3-6 as evidenced by their improved performance and accuracy in delayed gratification tasks (Anderson & Reidy, 2012; Carlson, 2005; Zelazo et al., 2003). Additionally, between the ages of 3-5 years old, there is significant development in mental shifting. Children as young as 3 years old can complete simple mental shifting tasks (i.e., sorting cards according to a set of rules; Carlson, 2005), but then have less success changing how they think about stimulus or change what aspect of the stimulus they attend to (Brooks, Hanauer, Padowska, & Rosman, 2003; Diamond, 2013). By the age 5 years old, there is a dramatic improvement in speed and accuracy

of switch trials, suggesting growth in their capacity to engage in mental shifting (Anderson & Reidy, 2012; Carlson, 2005).

Unlike working memory, inhibition, and mental shift, more complex executive functions including planning, goal setting, and emotion control take a more protracted course of development (Gioia et al., 2003). Goal setting includes planning and problem solving, and is often measured using the Tower of Hanoi task, a task that requires children to move three different sized disks across three pegs to achieve a specific model of configuration (Anderson & Reidy, 2012; Espy, Kaufmann, Glisky, & McDiarmid, 2001) A study conducted by Espy et al. (2001) found that performance on this task steadily inclined from 2.5 to 5 years old. At age 2.5 years old, children successfully completed a mean of 1.15 problems, whereas 5-year-old children completed a mean of 3.89 problems.

As an outcome of executive functioning, working memory, inhibition, and shifting have all been found to support emotional control (Baggetta & Alexander, 2016). Early forms of emotional regulation appear in infancy, as demonstrated by 18-24 month-olds capturing the attention of caregivers for support (Ursache, Blair, Stifter, & Voegtline, 2013); however, using cognitive processes necessary for problem solving and controlling emotions emerge later in preschool years (Liebermann, Giesbrecht, & Muller, 2007). Liebermann et al. (2007) found that by using inhibition and verbal abilities, older children (M = 5 years old) were better able to display more positive behaviors when they received an undesirable gift compared to younger children (M = 3 years old). This research highlighted the developmental incline in emotional control in the preschool years, and how executive function abilities, particularly inhibition, relate to emotional control.

Executive Functioning and Screen Use. Given that executive functions develop in early childhood and play a critical role in healthy development, it is important to understand potential factors influencing executive function performances. Recently, there is heightened interest in exploring the relationship between screen exposure and cognition in early childhood (Savina et al., 2017). Currently, much of the research on screen time and executive functioning is focused on traditional sources including TV and video consoles, and even so, the results of the research are not consistent in their findings. For example, educational and interactive TV programs such as Sesame Street have been found to aid literacy and cognition in 3-5 year-olds (Christakis et al., 2013), but in contrast, Lillard and Peterson (2011) found that fast-paced TV programs significantly and negatively impacted executive functions in 4-year-old children. Additionally, Rosenqvist et al. (2016) found that 5-7 year-old children who viewed more than two hours of TV per day scored poorly on executive function tasks, and higher computer use was significantly related to higher scores on language, memory, and social perception tasks.

Although educators and parents are hopeful that mobile devices will benefit their children, research on the relationship between mobile media use and executive functioning in preschool children is limited. For example, Huber, Yeates, Meyer, Fleckhammer, and Kaufman (2018) measured working memory, inhibition, and task switching performances in children 2-3 years old before and after an intervention. Children were randomly assigned to one of three conditions: Watching an educational TV show, playing with an educational app, or watching a cartoon. Children spent nine minutes on an iPad with one of the three conditions. These researchers found that the educational app condition benefited executive function performances. Indeed, children in the educational app condition performed better in a delayed gratification task

compared to those who watched a cartoon. Additionally, children in the educational app condition improved the most on a working memory task compared to the other two conditions.

A very recent study by Nathanson and Beyens (2018a) examined the relationship between mobile media use and effortful control, a form of self-regulation, in preschool children between 3-5 years old. This study used survey reports from 402 mothers on their child's mobile media use, sleep quality and quantity, and effortful control using questions from the Early Childhood Behavior Questionnaire. These researchers found a negative relation with tablet time and effortful control, and a positive relation with hand-held game players (e.g. Nintendo DS) and effortful control. These results suggests that as the child's tablet time increased, they had worse ratings of effortful control, but as their time spent using a hand-held game player increased, they are better ratings of effortful control. Additionally, sleep was a significant moderator; time using a tablet was significantly related to poorer effortful control among children who slept less than 10.61 hours a night, and time using a hand-held gaming device was positively associated with effortful control among children who slept more than 10.42 hours a night. Overall, these researchers conclude that future work should continue to explore the potential impact mobile media devices have on self-regulation in early childhood, while considering the effect of sleep (Huber et al., 2018; Nathanson & Beyens, 2018a). Indeed, self-regulation is related to social, academic, and behavioral outcomes among children (Gioia et al., 2003; Nathanson & Beyens, 2018a); therefore, it is an important behavioral outcome of executive functioning that is a significant variable of interest in the current study (Gioia et al., 2003; Nathanson & Beyens, 2018a).

Sleep in Preschool Children

Sleep Recommendations. Sleep is consistently identified as a critical physiological mechanism that impacts overall physical and mental health in otherwise healthy adults and children (Chaput et al., 2017; Seguin & Klimek, 2016). Meeting sleep recommendations has been found to impact many areas of child development, including growth, emotion regulation, cognition, and social skills (Chaput et al., 2017; Seguin & Klimek, 2016; Vaughn, Elmore-Staton, Shin, & El-Sheikh, 2015). The new 24-Hour Movement Guidelines released by the Canadian Society for Exercise Physiology recommends that preschoolers, 3-4 years old should get 10-13 hours of good quality sleep, including naps, each day/night, and that 5-year-olds need 9-11 hours of uninterrupted sleep a night (Tremblay et al., 2017). Fortunately, researchers have shown that 83.9% of Canadian and 88.7% of Australian preschoolers met the 24-hour sleep guidelines (Chaput et al., 2017; Cliff et al., 2017). Both studies found that preschool children were sleeping approximately 10.5-11 hours a day, and were much more likely to meet sleep recommendations compared to physical activity and screen time recommendations (Chaput et al., 2017; Cliff et al., 2017).

Sleep and Child Development. Sleep benefits children emotionally, physically, and cognitively. In regards to physical activity, a large-scale study comprised of 68,288 American children aged 6-17 years old found that children experiencing an inadequate amount of sleep for their age had 29% lower odds of physical activity than those who experienced adequate sleep (Singh, Kogan, Siahpush, & Dyck, 2008). Other research on sleep during early childhood is less conclusive. One study found that sleep duration did indeed positively relate to total physical activity in preschool children (Hinkley, Salmon, Okely, Hesketh, & Crawford, 2012); other

researchers, however, did not find any significant relationship (Schmutz et al., 2017; Sijtsma, Koller, Sauer, & Corpeleijn, 2015).

In addition, sleep has been found to be related to executive functioning. A systematic review conducted by Chaput et al. (2017) found supporting evidence that sleep duration was associated with emotional regulation and growth in preschool children. Moreover, they found evidence supporting that shorter sleep duration is associated with poorer cognitive functioning (Chaput et al., 2017). Indeed, a study conducted by Bernier et al. (2013) found that longer sleep duration in infancy was related to better performance on abstract reasoning, concept formation, and problem-solving tasks three years later, at 4 years old, after controlling for environmental variables (e.g. family socioeconomic status).

Sleep duration and sleep problems (e.g., sleep-disordered breathing) have been found to negatively impact vocabulary, emotional knowledge, and executive functions, including inhibition, working memory, and planning in preschool children (Karpinski, Scullin, & Montgomery-Downs, 2008; Nelson et al., 2015; Vaughn et al., 2015). Considering that executive function tasks rely heavily on frontal lobe function, research has identified impairments in creative thinking, verbal fluency, trail making, planning, inhibition, and memory following sleep deprivation (Jones & Harrison, 2001; Randazzo, Muehlbach, Schweitzer, & Walsh, 1998). Although there is no known single mechanism responsible for sleep related impacts on executive functions, some researchers identified frontal lobe deficits following sleep restriction (Jones & Harrison, 2001).

As indicated in the aforementioned study by Nathanson and Beyens (2018a), sleep seems to act as a moderator between mobile media use and self-regulation in preschool children, suggesting that children who sleep less than recommended amounts might be more vulnerable to

any negative implications of screen time. Moreover, they also found that evening tablet use between dinner and bedtime was associated with later bedtimes, bedtime resistance, and problematic sleep duration, which in turn, related to weaker effortful control. Similarly, another study conducted by Nathanson and Beyens (2018b) supports the evidence that evening mobile media use is related to sleep disturbances and shorter sleep duration in young children. In regards to traditional screen sources, findings from the 2004 National Sleep Foundation Sleep in America Poll indicated that 30% of preschool children had a TV in their bedroom, which related with approximately 30 minutes less sleep than those who did not have a TV in their bedroom (Mindell, Meltzer, Carskadon, & Chervin, 2009). Overall, it is evident from past research that sleep plays a critical role in child development, with relations between sleep, executive functioning, and (potentially) physical activity (Chaput et al., 2017; Hinkley et al., 2012). Newer research is also suggesting that sleep duration in preschool children is negatively influenced by mobile media use, and it remains unknown if sleep plays a mediating and moderating role in mobile media use and health outcomes (Nathanson & Beyens, 2018b).

Current Study

It is apparent from past research that limiting screen time, increasing physical activity, and getting sufficient amounts of sleep optimizes health outcomes, such as preventing obesity and promoting social-cognitive development in preschool children (Carson, Tremblay, & Chastin, 2017; Chaput, Carson, Gray, & Tremblay, 2014; Cliff et al., 2017). As noted above, many preschool children may not be meeting screen time guidelines, and in fact, may prominently exceed screen time recommendations (Rideout, 2017). Given this information, there is growing concern regarding the impact screen time has on sleep, and early cognitive and physical development (American Academy of Pediatrics, 2013; Savina et al., 2017). Therefore,

the aim of the current study is to investigate associations between mobile media use on measured executive functions (i.e., inhibition, shift, working memory, planning/organizing, and emotional control), parent-reported physical activity, and parent-reported sleep in preschool children. Accordingly, the research questions for this study are as followed:

1. **How much time are preschool children spending on screen devices and what devices are most commonly used?** Based on the research by Common Sense Media (Rideout, 2017), the current study will determine if a sample of Canadian preschool children follow similar trends of exceeding the recommended one-hour per day of screen use, watching TV, and using mobile devices most commonly.
2. **Are there differences in preschoolers' mobile media use and outcome variables by way of important demographic variables?** Previous researchers have found significant differences between demographic variables (i.e., gender, parental education, and time spent in a daycare) and measured screen time, physical activity, and executive functions (Gioia et al., 2003; Lindsay et al., 2017). However, research is lacking on how these individual differences are related specifically to mobile media use in preschool children. Therefore, this question will explore what between-group differences account for significant variance in mobile media use and outcome measures.
3. **What are the correlations amongst selected demographic variables, preschool child's mobile media use, and outcome variables?** As a first step in understanding the relationship between variables, this question will explore the strength and direction of continuous demographic variables (e.g. age), children's mobile media use, and outcome variables. More specifically, does age significantly and positively

correlate with physical activity, and does parent's screen use and children's age of first use of a mobile device significantly and positively correlate with children's mobile media use?

4. **How is time spent using mobile media devices related to preschoolers' executive functioning and physical activity?** As there is no general consensus on whether mobile media use is negatively correlated with executive functioning and physical activity in preschool children, this question will explore whether daily mobile media use is related to executive functioning and physical activity, and if the duration using mobile media (in minutes) correlates with executive functions and physical activity.
5. **Do preschool children's sleep habits moderate the relationship between mobile media use and measured outcomes?** The present study will attempt to confirm the findings by Nathanson & Beyens (2018a) that sleep moderates the relationship between mobile media use and measured outcomes, answering the question: Does less reported sleep contribute to increased variance (negatively) being accounted for between mobile media use and outcome variables?

CHAPTER 3

METHODOLOGY

Participants and Recruitment

Following ethics approval from The University of Calgary Conjoint Faculties Ethics Board, mothers and their children between the ages of 3-5 years old were recruited from Calgary and surrounding areas (i.e., Cochrane, Red Deer, Lethbridge). The study recruitment poster (see Appendix B) was presented to various early childhood development organizations and childcare centers in Southern Alberta. The recruitment poster was also posted on the following social networking sources: Facebook, Twitter, and Instagram. The poster explained that we were seeking mothers and their children between the ages of 3-5 years old to participate in a research study exploring the effects of playtime activities on childhood development. In appreciation of their time, the poster stated that all participants, child and parent, would each receive a $10 gift card upon completion of their participation in the study. Interested individuals were instructed to contact the researcher via email or visit the research lab website.

Inclusion criteria included limiting parent participation to the female caregiver and to those who were proficient in English, given that the measures required parents to have at least a fifth-grade reading level (Gioia et al., 2003). Given that different neurological and behavior disorders impact executive functioning (Gioia et al., 2003), children were excluded from this study if they had a medical of psychiatric condition impacting their cognitive functioning (e.g., Autism Spectrum Disorder, Intellectual Disability, ADHD, and/or a concussion or head injury).

Measures

Demographic Information. The demographic questions completed by the mothers included highest level of education completed as a measure of socioeconomic status, gender, age,

and ethnicity. Parents were also asked about their current employment status (e.g., full-time, part-time, unemployed), their family structure (e.g., two-parent household, single-mother household), and the number of children living in the household. Demographic questions about the child included their birth date, gender, and ethnicity. Moreover, parents were asked if their child attended a daycare or preschool, and if so, how many hours a week, if their child experiences any significant illness, if they take any medication, and if they are concerned about their eating habits. See Appendix C for the full list of demographic questions.

Screen Time Survey. To measure screen time, an adapted version of the Zero to Eight Common Sense Media survey was used (Kabali et al., 2015; See Appendix D). This parent questionnaire provides estimates of child's screen time in four areas: TV, mobile devices (smartphones, iPod, and tablets), computers, and video consoles (Xbox, PlayStation, and Nintendo). Overall, this questionnaire has demonstrated acceptable face validity by the senior faculty members; however, reliability has not been tested but was chosen given it's emphasis on mobile media use (Kabali et al., 2015).

First, to measure children's access to screen devices, parents were asked to select various devices they have in their household, what devices, if any, their child owns, and what devices, if any, are allowed in their child's bedroom. To examine children's age at first use, parents were asked how old their child was when he/she first did various activities on a mobile device (e.g., used apps, called someone). As a measure of children's efficiency using a mobile device, parents were asked if their child needed help to navigate mobile devices (response options were "always," "sometimes," and "never"). Parents were also asked what activities their child has ever done on a mobile device (e.g., watch videos, use apps). To measure the circumstances under which parents let their child use a mobile device, parents were asked how often they let their

child use a mobile device when running errands, doing chores around the house, keeping their child calm in a public setting, or putting their child to sleep. Response options were “often,” “sometimes,” “hardly ever,” and “never.”

To examine children’s screen time viewing, parents were asked about the frequency of their child’s total screen time viewing on different devices (i.e. watching TV, using a computer); response options were “several times a day,” “once a day,” “several times a week,” “once a week,” “less than once a week,” and “never.” As well, parents were asked to estimate the amount of time their child spent on a screen device each day; responses were “none,” “less than 30 minutes,” “about 30 minutes,” about 1 hour,” and “more than one hour.” Additionally, parents were asked how many apps they have downloaded in their phone, which apps are downloaded for their child, and to rank how they determine which apps their child plays (i.e., education value, price, attraction).

To understand parent’s personal screen time viewing and how they monitor their child’s screen time, parents were also asked how much time they spent on the computer, internet, smartphone, and tablet the previous day at home (not working). Response options were 5-30 minutes, 30-60 minutes, 1-3 hours, over 3 hours, or not at all. Moreover, they were asked if they have household rules about screen time and use, and if so, how do they enforce the rules and does their child follow these rules.

Physical Activity Questionnaire. After surveying the literature for adequate questionnaires measuring physical activity in preschool children, the physical activity questionnaire used from the All Our Families study best suited the current research design (All Our Families Study, n.d.; Appendix E). All Our Families study is a longitudinal child development study implemented by Tough and colleagues (All Our Families Study, n.d.) from

Calgary, Alberta. Researchers and professionals in the field developed various physical activity questions designed for young children. Parents were asked to indicate the number of hours per day their child engaged in unstructured play and read books on a 5-point Likert scale ranging from none to 5-or-more hours a day. Additionally, parents were asked how many hours per week their child engaged in non-sports lessons (e.g., music class) and physical activity lessons. They were also asked how many times their child engages in mild, moderate, or strenuous activity in a typically week, and if they believe their child gets enough physical activity or needs more.

Executive Functioning. There is no commercially available standardized measure of executive functions for preschool-age children (Anderson & Riedy, 2012). Although neuropsychological, cognitive, and intellectual standardized tests include some aspects of executive functions, there are very limited subtests applicable for 3-4 year-old children. In the current study, the Statue subtest from A Development Neuropsychological Assessment – Second Edition (NEPSY-II) was administered to the child participants. Parents also completed the Behavior Rating Inventory of Executive Function®- Preschool Version (BRIEF®-P) as a behavioral measure of executive functioning.

The NEPSY-II is a standardized measure of neurocognitive processes in children 3-16 years old (Korkman, Kirk, & Kemp, 2007). The Statue subtest used in the current study was used to measure inhibition in motor persistence in children ages 3-6 years old. Children were asked to maintain a body position with their eyes closed during a 75-second period and to inhibit the impulse to respond to sound distracters. The NEPSY-II has previously demonstrated good reliability (.82 – .88) and strong validity (Korkman et al., 2007). Highlighting the limited measures of executive functioning in early childhood, the Statue subtest is the only measure in the attention and executive functioning domain of the NEPSY-II that can be administered to

children under 5 years old.

The BRIEF®-P is a parent-rating scale on children's executive functions (Gioia et al., 2003). It produces five clinical scales: inhibit, shift, emotional control, working memory, and plan/organize. Additionally, the global executive composite is a summary that incorporates all clinical scales. Parents rate how often their child had a problem with various behaviors over the last 6 months. A higher score on the BRIEF-P indicates more problematic executive function behavior.

In parent samples, the developers reported good internal consistency (.80 - .95) and moderate test-retest reliably (.78 - .90). Research using a Canadian community sample reported that the BRIEF®-P parent-report scales have good internal consistency (.79 - .90) and adequate convergent validity to the Child Behavior Checklist (r = .15 to r = .81; Duku & Vaillancourt, 2014). This measure provides useful information regarding behavioral manifestations of executive functions in children that standardized measures cannot assess.

Sleep. The Children's Sleep Habits Questionnaire preschool and school aged version (CSHQ) was used to measure sleep behaviors of children (Owens, Spirito, & McGuinn, 2000). The CSHQ is a 33-item parent questionnaire that assesses their child's bedtime, sleep behavior, waking during the night, and morning wake-up. Parents were asked to recall these behaviors over a typical, recent week and rate items on a 3-point Likert-type scale ranging from "usually" (5-7 times a week), "sometimes" (2-4 times a week), and "rarely" (zero to one time a week). A higher score indicates more disturbed sleep. Additionally, parents were asked what their child's usual bedtime and wake time is, the numbers of hours they sleep per night, and the number of hours they nap per day. The CSHQ has demonstrated acceptable validity, internal consistency (α = .70)

and test-retest reliability (r^c = .62 - .79) in community samples of children aged 4-10 years old (Owens et al., 2000).

Procedure

After participants contacted the researcher, they were asked the following questions to determine eligibility: 1) "What/city town do you currently live in?" 2) "Are you and your child proficient in English?" 3) "Do you have at least a 5 grade reading level?" and 4) "Does your child have any medical or psychiatric condition impacting their cognitive functioning, including Autism Spectrum Disorder, Intellectual Disability, Attention Deficit Hyperactive Disorder (ADHD), and a Concussion or Head Injury." Eligible participants were given a unique four-digit code provided by the researcher to be used for the questionnaires. The unique code was provided to protect the anonymity of both the parent and the child, ensuring that only the principal investigators were able to link responses to a participant's email address. Parents were directed to a link that took them to SurveyMonkey, an online website platform used to create the survey and collect data. Parents were first asked to type in their unique ID, and then they were directed to the informed consent page. If participants select no to the informed consent, they were directed to a new page thanking them for their consideration.

Those who had given consent were directed to demographic questions, the physical activity questionnaire, the screen time questionnaire, and the sleep questionnaire. Once the parent had completed the survey, the researcher emailed them the link to the BRIEF-P through the PARiConnect account. After this, the researcher emailed participants to set up a meeting to administer the NESPY-II to their child. To provide the parents with flexibility, the researcher gave the parents the option to meet at their home, a library nearby, or at the University of Calgary. Additionally, to ensure the child was comfortable, parents were given the option to stay

in the room, at the requirement that they do not disturb the administration of the NEPSY-II subtest. The meeting took approximately 20 minutes. Following completion of the assessment, children were given a small prize and parents received a $10 gift card to Indigo.

Data Preparation

The frequency and duration of preschool children's mobile media use from the screen time survey were used as independent variables. Following the procedure used by Kabali et al. (2015), response options for the child's frequency of screen time viewing were combined into "daily" (i.e., several times a day, once a day, several times a week) and "less than daily" (i.e., once a week, less than once a week, never). Additionally, the duration of preschool children's screen time viewing responses were transformed into a continuous variable by assigning a value in minutes to each response: "none" = 0 minutes, "less than 30 minutes" = 15 minutes, "about 30 minutes" =30 minutes, "about 1 hour" = 60 minutes, and "more than 1 hour" =90 minutes. All other responses from the screen time survey were used as descriptive information.

For the BRIEF-P, a *t*-score was produced, which provided information about an individual's score relative to same-aged peers. A higher *t*-score indicates higher the problem with the executive function, with a *t*-score over 65 being considered as potentially clinically significant (Gioia et al., 2003). Additionally, the raw scores from the Statue subtest from the NEPSY-II were converted to scaled scores to determine how an individual's score is relative to the normative sample (Korkman et al., 2007). Scaled scores range from 1-19, (M = 10, *SD* = 3) with a higher score representing a better performance.

To create the physical activity variable, a sum score for the number of times the child engaged in mild, moderate, or strenuous activity in a typical week was created. The number of hours per day the child engaged in unstructured play, the hours per week the child engaged in

non-sports and physical activity lessons, and if the parents believed their child needed more physical activity was used as descriptive data. Lastly, the reported amount of hours of sleep per night was used as the sleep variable.

Statistical Analyses

Statistical analyses were run using IBM SPSS Statistics 24. Before running analyses, the data set was examined to identify outliers, missing, and out of range data points. Overall, only one physical activity outlier was identified by a standardized value greater than 3 and was subsequently deleted (Aguinis, Gottfredson, & Joo, 2013). Six values were missing from the physical activity variable, and three values were missing from the NEPSY-II. Due to a design error on the CHSQ, many participants misunderstood to both rate the child's severity of sleep disturbance *AND* indicate whether it is a problem or not. For example, some participants selected that the sleep behavior was a problem but did not rate its severity. Therefore, more than 20% of the global and subscales scores were missing and thus, were not included in the analysis (American Association for Public Opinion Research, 2016). Instead, the number of hours of sleep per night was used as a moderator variable, which was used by previous researchers (Nathanson & Beyens, 2018a). No data points were found to be out of range. Lastly, considering the sample size (N= 32), the number of dependent variables analyzed had to be limited so that the resulting analyses would have sufficient power to detect moderate to large effect sizes (VanVoorhis & Morgan, 2007). For instance, a general rule of thumb is at least 10 participants per variable to achieve acceptable power estimates (VanVoorhis & Morgan, 2007). Therefore, the emotional control clinical scale from the BRIEF-P was chosen as the main variable of interest, given that recent research by Nathanson and Beyens (2018) found a significant relationship between self-regulation and executive functions in preschool children.

First, to address how much time children are spending using screen devices and what devices they are most commonly using, descriptive data was computed and analyzed. This included descriptive information on children's daily versus non-daily screen time use, and screen time viewing per day (in minutes) were calculated to determine how much time children engaged with screen devices and what devices are most commonly used. To explore research question two, if between group differences explain significant variance in mobile media use, physical activity, and executive functions, a series of Mann-Whitney U tests were conducted. This non-parametric test was used since mobile media use (in minutes per day) was not normally distributed. A median split was used to create a dichotomous variable for parent's education, parent's employment status, and the number of hours the child spends in daycare each week. Given the dichotomous nature of the sex of the child (i.e. male or female) and normally distributed data, an independent samples *t*-test was conducted to determine if executive function scores and physical activity reports differ between the sex of the child (i.e., male or female). Next, correlations were conducted to answer research question three; examining the relationship amongst selected continuous demographic variables, preschool child's mobile media use, and outcome variables. Children's media use (in minutes) was computed into one continuous variable by totaling parent reports on the number of minutes their child uses apps and watches videos on a mobile device each day. For research question four, an independent sample *t*-test was conducted to determine whether there was a significant difference between those children using mobile devices daily compared to those who were non-daily users by way of outcome variables. Lastly, for research question five, to address if sleep moderates the relationship between mobile media use and measured outcomes, a moderation regression analysis was conducted for mobile media use (in minutes). Linear regression analyses were used to test the moderation relationship.

The analyses indicated the interaction term between mobile media use and sleep hours per night, and reported physical activity and executive functions as dependent variables. The interaction term was used to determine if sleep accounted for a significant amount of variance in the dependent variables. For all analyses, an alpha level of $p < .05$ was used to determine significance.

CHAPTER 4

RESULTS

Description of Sample

Overall, a total of 30 mother-child dyads completed the study ($N = 32$); two individual mothers completed the questionnaires but their children were unable to partake in the research. Mothers ranged from 27 to 49 years of age ($M = 35.5$, $SD = 4.71$), and children from 3 years, 0 months to 5 years, 11 months of age ($M = 4.23$; $SD = .69$), with 17 (53.1%) males and 15 (46.9%) females. As shown in Table 1, the majority of the parents and children were Caucasian (84.4% and 78.1%, respectively), over a third of parent participants worked full-time (37.5%), and over a third had a university degree (37.5%). Most children (78.1%) also spend time in daycare/childcare, spending an average of 29.5 hours in childcare per week ($SD = 14.70$). Lastly, 93.8% participants were from a two-parent household (i.e., all members biologically related), one participant was from a two-parent blended household, and one from a two-parent household with some members adopted.

Screen Habits and Exposure

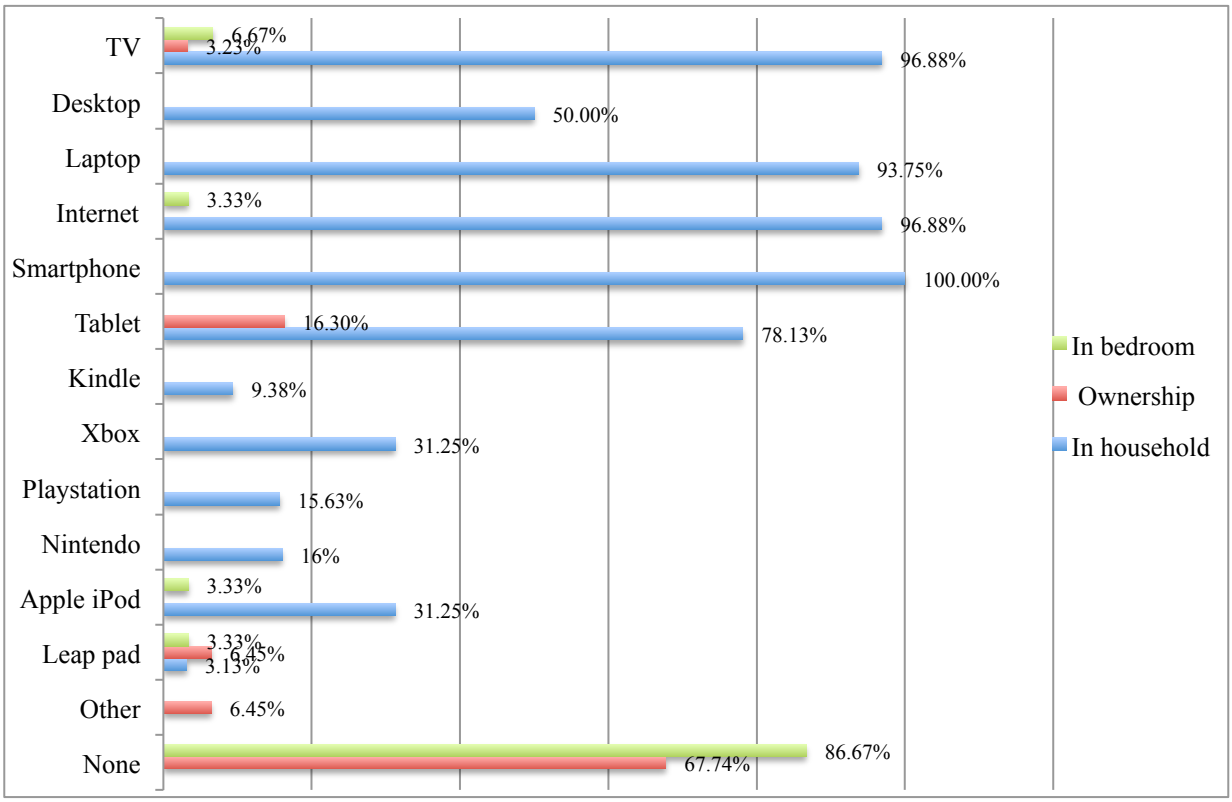
Children's Screen Exposure. Figure 1 shows preschool children's screen exposure in their household, child ownership of their own screen device, and devices in their bedroom by way of sample percentages. All households indicated that they owned a smartphone (100%, $n = 32$), and most had internet access (96.88%, $n = 31$), TV (96.88%, $n = 31$), a laptop (93.75%, $n = 30$), and at least one tablet (78.13%, $n = 25$). Most parents reported that their child did not own his/her own screen device (67.74%, $n = 21$), and the most commonly owned device was a tablet (16.30%, $n = 5$). The majority of children did not have any screen device in their bedroom (86.67%, $n = 26$).

Table 1

Frequencies

Variable	Frequency	Percent	Cumulative Percent
Children's Age			
3-years-old	5	15.6%	15.6%
4-years-old	13	40.6%	56.3%
5-years-old	14	43.8%	100%
Employment			
Full-time	12	37.5%	37.5%
Part-time	9	28.1%	65.6%
Not employed	9	28.1%	93.8%
Maternity leave	2	6.3%	100%
Education			
High school	2	6.3%	6.3%
Technical diploma	6	18.8%	25%
University degree	12	37.5%	62.5%
Graduate degree	10	31.3%	93.8%
Professional degree	1	3.1%	96.9%
Student	1	3.1%	100%
Household			
Two-parent household all members biologically related	30	93.8%	93.8%
Two-parent blended family	1	3.1%	96.9%
Two-parent household with adopted children	1	3.1%	100%
Parent ethnicity			
Asian or Pacific Islander	2	6.3%	6.3%
White/Caucasian	27	84.4%	90.6%
Prefer not to answer	3	9.4%	100%
Child ethnicity			
Asian or Pacific Islander	2	6.3%	6.3%
Hispanic or Latino	1	3.1%	9.4%
Mixed	2	6.3%	15.6%
White/Caucasian	25	78.1%	93.8%
Prefer not to answer	2	6.3%	100%
Child Care			
Yes	25	78.1%	78.1%
No	7	21.9%	100%

Figure 1. *Children's screen exposure*



Children's Mobile Device Efficiency. Overall, 60% (n = 18) of parents responded that their child sometimes needs help to navigate a mobile device, 30% (n = 9) responded that their children always needs help, and 10% (n = 3) responded that their child never needs help.

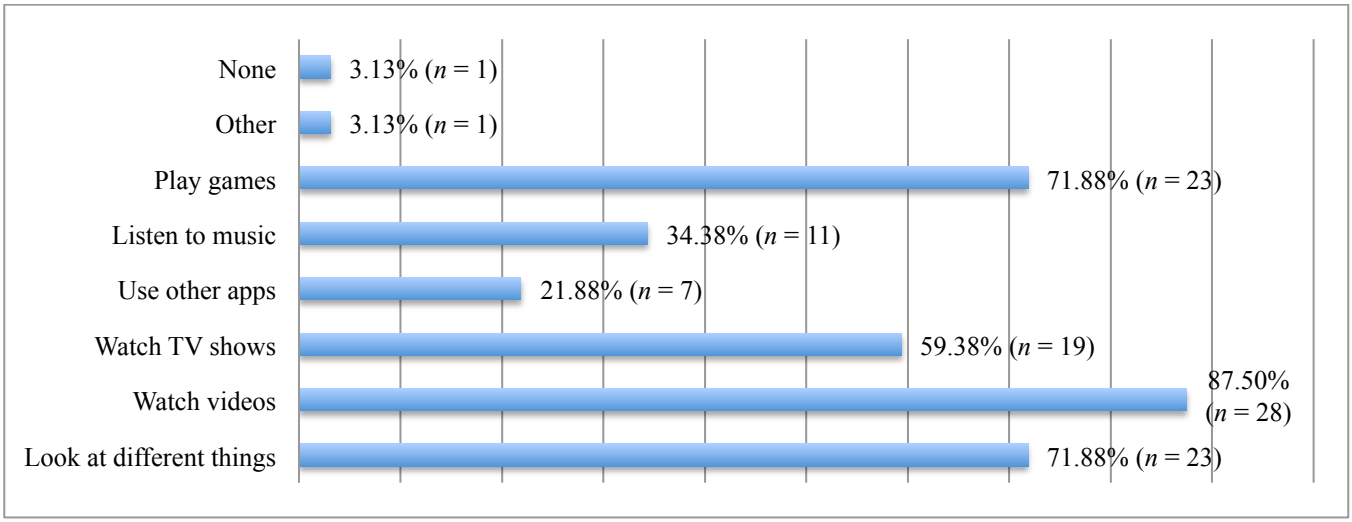
Activities on a Mobile Device. As shown in Figure 2, most parents (87.5%, n = 28) reported that their child used a mobile device to watch videos, play games (71.88%, n = 23), or touch or scroll the screen to look at different things (71.88%, n = 23). The least common activity children were reported to do on a mobile device is use other apps (21.88%, n = 7).

Age of First Use. Parents reported that average age their child first touched or scrolled through a mobile device to look at different things was two years of age (M = 2.0), and the mean first age that the child called someone using mobile technology was three and a half years (M = 3.5). Additionally, parents reported that the age that their child first used a mobile device to play

videogames was just under five ($M = 4.8$), and to play with apps was just over three years of age ($M = 3.3$).

Figure 2.

Types of activities children have done on a mobile device



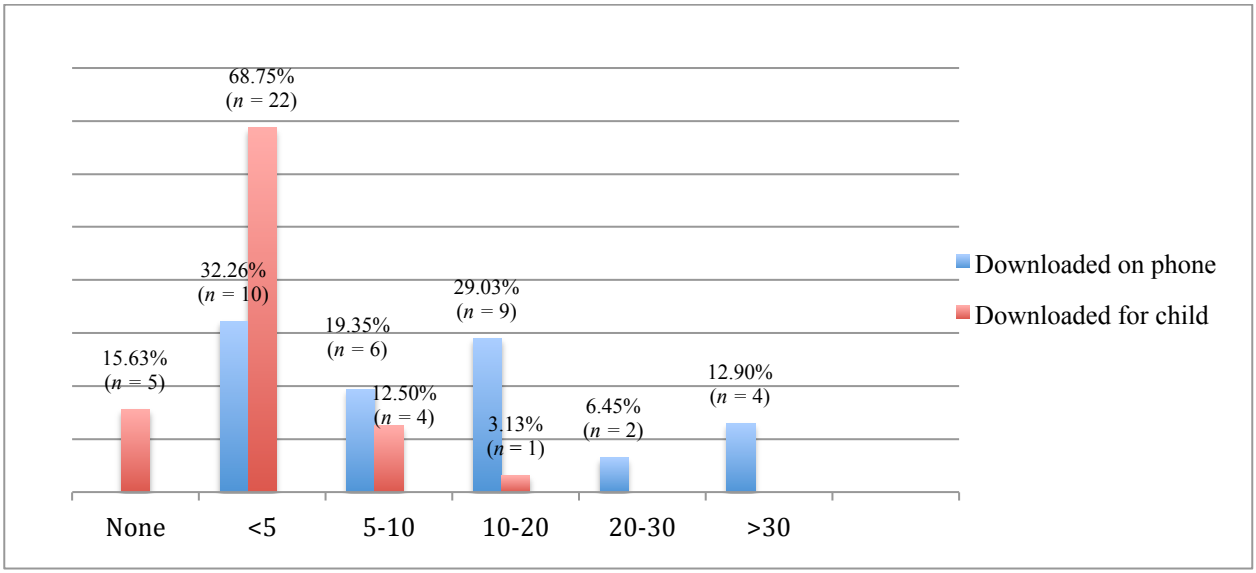
Circumstances in which parents let their children use mobile devices. Almost half of the parents reported that they let their child use a mobile device ("sometimes" or "often") when they did chores around the house (43.73%, $n = 14$). For the remaining parent participants, 18.75% ($n = 6$) "sometimes" let their child use a mobile device to keep them calm in public gatherings, 12.5% ($n = 4$) "sometimes" let their child use a mobile device when they are out running errands, while only 3.1% ($n = 1$) "sometimes" let their child use a mobile device when putting them to sleep.

Applications. As shown in Figure 3, most parents reported having fewer than five apps downloaded onto their smartphone, iPod, laptop, Kindle, iPad, tablet, or other mobile device, and the majority of parents indicated that fewer than five of those apps were downloaded for their child's use. With regards to how parents choose what apps their child plays, most (53.33%, $n =$

16) ranked educational value first, price second (40%, *n* = 12), and attraction last (45.16%, *n* = 14).

Figure 3.

Number of applications on phone



Monitoring. Almost all parents (91%, *n* = 29) indicated that they had household rules about screen time and use. All parent respondents also indicated that they have limited the amount of screen time (*n* = 29), 30% (*n* = 8) have used parent control or software blocks on the internet or TV, 22% (*n* = 6) have checked the search/website history regularly on their child's device, 63% (*n* = 17) have asked their child to leave their screen device outside their bedroom, and 82% (*n* = 23) have removed screen privileges for inappropriate use, overuse, or failure to follow rules. Moreover, 93% (*n* = 27) responded that their child often follows the rules regarding screen time and use, and seven percent (*n* = 2) indicated that their child "sometimes" follows the rules.

Parent self-reported screen use. Parents self-reported spending the majority of their own screen time outside of working using the internet and using a smartphone (see Table 2).

Specifically, 58.6% (n = 17) reported spending more than one hour per day using the internet, 46.67% (n = 14) reported spending more than one hour per day using their smartphone, 19.23% (n = 5) reported spending more than one hour per day using a computer, and lastly, only 14.8% (n = 4) spend more than one hour per day using a tablet outside of that required for work.

Table 2

Frequencies of parent media use

Variable	Frequency	Percent	Cumulative Percent
Computer			
Do not own	2	7.4%	7.4%
5-30 minutes	17	63%	70.4%
30-60 minutes	3	11.1%	81.5%
1-3 hours	4	14.8%	96.3%
3+ hours	1	3.7%	100%
Internet			
Do not own	0	0%	0%
5-30 minutes	8	27.6%	27.6%
30-60 minutes	4	13.8%	41.4%
1-3 hours	15	51.7%	93.1%
3+ hours	2	6.9%	100%
Smartphone			
Do not own	0	0%	0%
5-30 minutes	8	26.7%	26.7%
30-60 minutes	8	26.7%	53.3%
1-3 hours	12	40%	93.3%
3+ hours	2	6.7%	100%
Tablet			
Do not own	12	44.4%	44.4%
5-30 minutes	10	37%	81.5%
30-60 minutes	1	3.7%	85.2%
1-3 hours	4	14.8%	100%

Descriptive Statistics. As shown in Table 3, the mean scaled score on the NEPSY-II is 8.45, which is considered to be in the Average range compared to same-aged peers (Korkman et al., 2007). Similarly, the mean t-scores on the BRIEF-P global executive composite (M = 49.56) and the emotional control clinical scale (M = 49.53) is in the Average range in relation to the

comparative sample (Gioia et al., 2003). Parents reported that their child spends *M* = 13 times per week engaging in "mild," "moderate," and "strenuous" physical activity. Results of the correlation matrix between each physical activity variable (i.e., mild, moderate, strenuous) are shown in Table 4, which indicate all items are significantly and positively correlated. Most parents (78.78%, *n* = 26) reported that their child spends three or more hours engaging in unstructured play (e.g., playing ball, doing a craft) per day on weekdays and 71.88% (*n* = 23) parents reported that their child engages in unstructured play for five or more hours per day on weekends. On average, parents reported that their child spends just over two hours per week (*M* = 2.15) in lessons or receiving instruction in organized physical activities with a coach or instructor (e.g., dance, soccer). Additionally, 78.79% (*n* = 26) of parents responded that their child gets enough physical activity. In regards to sleep, parents reported that their child experiences almost 11 hours of sleep per night (*M* = 10.71 hours of sleep per night), ranging from 10 hours to 12 hours.

Table 3

Descriptive Statistics

Variable	*N*	Min	Max	Mean	Range	Std.	Variance	Skewness	Kurtosis
NEPSY-II	29	2	15	8.45	13	3.52	12.40	.24	-.88
BRIEF Global	32	35	73	49.56	38	9.84	96.90	.81	-.10
BRIEF EC	32	38	64	49.53	26	8.84	69.48	.03	-1.46
Mild PA	31	2	14	5.85	12	2.89	8.35	1.35	2.48
Moderate PA	29	1	10	4.69	9	2.52	6.37	-.01	-1.08
Strenuous PA	28	0	7	3.73	7	2.47	6.08	.22	-1.45
Total PA	26	3	24	13.33	21	5.58	31.14	.16	-.80
Sleep per night	32	10	12	10.71	3	0.73	.54	.14	-.62

Note. BRIEF EC = emotional control score on the BRIEF-P. PA = physical Activity. Sleep per night = hours of sleep.

Table 4

Correlations Between Physical Activity Items

	Items	Mild	Moderate	Strenuous
Pearson Correlation	Mild			
	Moderate	.54**		
	Strenuous	.63**	.50**	

Note. ** Correlation significant at $p < .001$.

Research Question 1: How much time are children spending on screen devices and what devices are most commonly used?

As shown in Figure 4, 91% of children were reported by their parents to watch TV daily, and 44% were reported to use a mobile device daily on which to play games, use apps, or watch videos. No child was reported to have played on a video console. Table 5 shows the number of minutes per day children are spending on various screen sources. Children were reported to spend an average of approximately 23 minutes per day watching TV, 7 minutes watching videos on a mobile device, and 4 minutes using apps. Overall, parents reported that the children in this study spend an average of 34 minutes per day using any type of screen device ($M = 33.75$, $SD = 32.33$) and just over 10 minutes per day ($M = 10.31$, $SD = 21.36$) using a mobile device.

Figure 4

Percent of children using screen devices daily

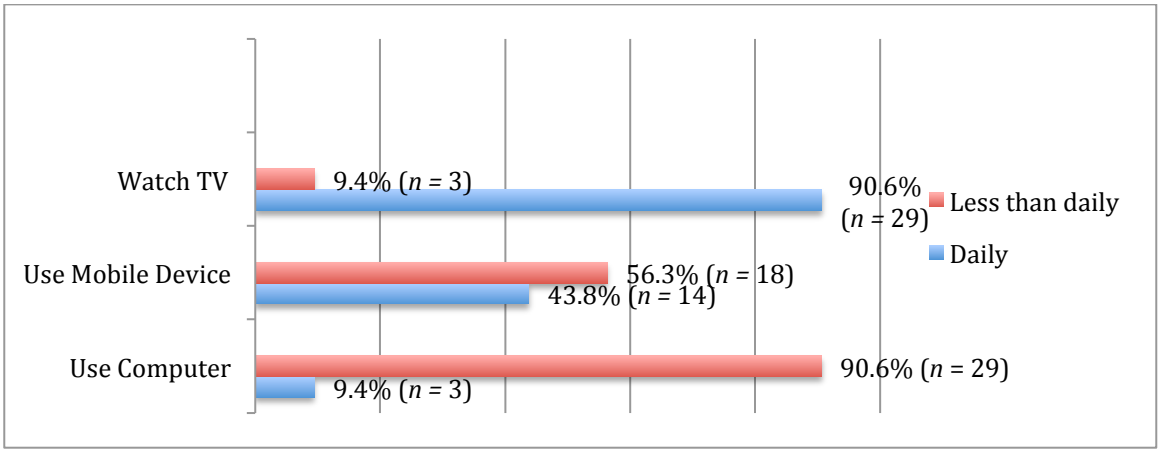


Table 5

Minutes spent using each device daily

Device	*N*	Min	Max	Mean	Range	Std.	Variance	Skewness	Kurtosis
Using Apps	32	0	30	3.75	30	9.33	87.10	2.36	4.23
Watching TV	32	0	90	22.50	90	25.84	667.74	.93	-.13
Watching videos	32	0	60	6.56	60	14.22	202.32	2.37	5.70
Total mobile	32	0	90	10.31	90	21.36	456.35	2.38	5.85
Total	32	0	120	33.75	120	32.33	1045.16	.91	.27

Note. Watching videos = watching videos on mobile device. Total mobile = total number of minutes using mobile device (using apps + watching videos). Total = total number of minutes on all devices (using apps + watching TV + watching videos).

Research Question 2: Are there differences in mobile media use and outcome variables by way of important demographic variables?

Given the non-normal distribution of mobile media use (in minutes per day), a series of Mann-Whitney U tests were run to determine if there were between-group differences in a child's mobile media use (in minutes per day) via the sex of the child, hours spent in daycare, and parent's highest level of education. Distributions of mobile media use for males and females, hours in daycare (32.5 hours a week or under), and parents' education (graduate school degree or under) were normal, as assessed by a visual inspection of the popular pyramid chart. Mobile media use for females (mean rank = 18.94) and males (mean rank = 13.73) was not statistically significant, $U = 86$, $z = -2.06$, $p = .12$. Additionally, mobile media use for children who spent less than 32.5 hours in daycare/week (mean rank = 17.34) and over 32.5 hours/week (mean rank = 14.57) was not statistically significant, $U = 98.50$, $z = -1.16$, $p = .40$. Lastly, children's mobile media use did not significantly differ between parents who had a graduate school degree or

higher (mean rank = 13.32) and parents who had less than a graduate degree (mean rank = 17.48), $U = 80.50$, $z = -1.59$, $p = .23$. See Table 6 for results.

Table 6

Mann-Whitney U Comparison of Mobile Media Use and Independent Variables

Groups	*n*	Mean rank	*U*	*z*	*p*
Males	15	13.73	86	-2.06	.12
Females	17	18.94			
Daycare < 32.5 hours	16	17.34	98.5	-1.16	.40
Daycare ≥ 32.5 hours	15	14.57			
Graduate degree ≥	11	13.32	80.5	-1.59	.23
< Graduate degree	20	17.48			

An independent samples *t*-test was conducted to determine if executive function scores and reports of physical activity differ by way of the sex of the child (i.e., male or female). Preliminary assumption checking revealed that all variables were normally distributed as indicated by a visual inspection of the histograms and skewness values between +/- 2 and kurtosis values between +/-4 (Field, 2009). The assumption of homogeneity of variances ($p > .05$) was met as assessed by Levene's Test for Equality of Variances. As shown in Table 7, results indicated that females performed significantly higher on the NEPSY-II ($M = 9.75$, $SD = 3.15$) compared to males ($M = 6.85$, $SD = 3.39$), $t(27) = 2.39$, $p = .02$. Additionally, males had a significantly higher emotional control clinical score ($M = 52.53$, $SD = 8.37$) than females ($M = 46.88$, $SD = 7.57$), $t(30) = -2.01$, $p = .05$, indicating higher problematic rating of emotional control. There was no significant difference between males ($M = 53.07$, $SD = 10.55$) and females ($M = 46.47$, $SD = 8.29$) on the BRIEF-P global executive composite, $t(30) = -1.98$, $p = .06$. As

well, there was no significant difference between males (M = 13.41, SD = 6.04) and females (M = 13.27, SD = 5.43) on reported physical activity, $t(24) = -.06$, $p = .95$.

Table 7

Comparison in Outcome Variables and Sex

	Sex					
	Male		Female		Comparisons	
Outcomes	*M* (*SD*)	*n*	*M* (*SD*)	*n*	*t* (df)	*p*
BRIEF-P Global	53.07 (10.55)	15	46.47 (8.29)	17	-1.95 (30)	.06
BRIEF-P EC	52.53 (8.37)	15	46.88 (7.57)	17	-2.01 (30)	.05
NEPSY-II	6.85 (3.39)	13	9.75 (3.15)	16	2.39 (27)	.02
Physical Act.	13.41 (6.05)	11	13.27 (5.43)	15	-.06 (24)	.95

Note. BRIEF-P EC = Emotional control on BRIEF-P. Physical Act = Physical activity.

Research Question 3: What are the correlations amongst selected demographic variables, child mobile media use, and outcome variables?

Partial correlations were conducted to determine the relationship between the mean age children first used a mobile device, parent's self-reported screen use, children's age, parent's age, children's daily mobile media use, and total minutes using a mobile device, while controlling for child's gender. As shown in Table 8, there was a significant correlation between children's age at first use of a mobile device and parent's media use (r = -.51, p = .01); meaning that as parent's media use increased, the earlier age their child first used a mobile device. There were no significant correlations between other demographic variables and children's media use.

Partial correlations were also performed to explore the relationship between children's age, parent's age, parent's education, hours in daycare per week, parent-reported physical activity, executive function scores, and sleep for their preschool child, while controlling for the child's gender. As shown in Table 9, there was a significant and negative correlation between children's age and parent-reported physical activity (r = -.47, p = .02), and a significant and negative correlation between children's age and the BRIEF-P global executive composite score

(r = -.38, p = .04). These results indicate that as the child's age increases, their reported physical activity per week decreases. Additionally, as the child's age increases, their problematic executive function behaviors increase. There was also a significant and positive correlation between parent's education and children's emotional control (r =.46, p = .01). These results mean that as a parent's educational level increases, so does their child's score on the emotional control clinical scale, indicating more reported problematic emotional control. Lastly, there was a significant correlation between hours per week in daycare and hours of sleep per night (r = -.49, p = .02), indicating as hours in daycare each week increase, hours of sleep per night decreases. There was no significant correlation for parent's age.

Table 8

Partial Correlations Between Demographic Variables and Mobile Media Use

	Items	First use	Child's age	Parents age	Parent's screen use	Daily Media	Media Use
Pearson Correlation	First use						
	Child's age	.04					
	Parent's age	-.11	.29				
	Parent's screen use	-.51*	-.15	.06			
	Media frequency	.02	.10	.21	-.01		
	Media duration	.27	-.15	-.30	-.26	.02	

Note. * Correlations significant at $p < .05$. ** Correlations significant at $p < .01$. First use = Age at first use on a mobile device. Daily media = daily mobile media use. Media use = mobile media use per day in minutes.

Table 9

Partial Correlations Between Demographic Variables and Outcome Variables

	Items	Childs age	Hours in daycare	Parent's age	Highest education	Physical Act.	NEPSY-II	BRIEF Global	BRIEF EC	Sleep
Pearson Correlation	Child's age									
	Hours in daycare	-.29								
	Parent's age	.29	.31							
	Highest education	.04	.14	.23						
	Physical Act.	-.47*	.19	-.25	.09					
	NEPSY-II	-.01	-.06	-.05	-.01	-.15				
	BRIEF Global	-.38*	.14	-.25	.28	.07	-.01			
	BRIEF EC	-.07	.25	-.08	.46**	-.09	.13	.69**		
	Sleep	.27	-.49*	.11	-.14	-.23	.07	-.30	-.25	

Note. * Correlations significant at $p < .05$. ** Correlations significant at $p < .001$. BRIEF Global = Global score on the BRIEF-P. BRIEF EC = Emotional control on BRIEF-P. Physical Act = Physical activity. Highest education = parents highest level of education. Sleep = hours per night child sleep.

Research Question 4: How is time spent using mobile media devices related to executive functions and physical activity?

Partial correlations were performed to determine the relationship between executive functions, reported physical activity, and mobile media use (in minutes), while controlling for children's gender. As shown in Table 10, no significant correlations were found between mobile media use and outcome variables. An independent samples *t*-test was conducted to determine if there were significant differences in daily mobile media use (i.e., daily versus non-daily users) and their respective executive functioning scores and physical activity reports. As shown in Table 11, children who were reported to use mobile media devices daily ($M = 46.29$, $SD = 6.70$) had lower rated scores on emotional control, indicating less problematic emotional control, compared to children who did not use mobile devices daily ($M = 52.06$, $SD = 8.77$), $t(30) = 2.04$,

$p = .05$. There were no significant difference between daily users ($M = 47.24$, $SD = 9.48$) and non-daily users ($M = 51.22$, $SD = 10.07$) on the BRIEF-P global executive composite, $t(30) = 1.09$, $p = .29$. Likewise, there was no significant difference in the NEPSY-II performance between daily users ($M = 9.25$, $SD = 3.72$) and non-daily users ($M = 7.88$, $SD = 3.37$), $t(27) = -1.03$, $p = .32$. Lastly, there was no significant difference in reported physical activity between daily users ($M = 11.50$, $SD = 5.17$) and non-daily users ($M = 14.67$, $SD = 5.65$) $t(24) = 1.46$, $p = .16$.

Table 10

Partial Correlations Between Mobile Media Use and Outcome Variables

	Items	Mobile	BRIEF-P Global	BRIEF-P EC	NEPSY-II	Physical Act.
Pearson Correlation	Mobile					
	BRIEF-P Global	.03				
	BRIEF-P EC	-.19	.69**			
	NEPSY-II	-.01	-.01	.13		
	Physical Act.	.04	.07	-.09	-.15	

Note. ** Correlations significant at $p < .001$. Mobile = Minutes on mobile device/day. BRIEF-P EC = Emotional control on BRIEF-P. Physical Act = Physical activity.

Table 11

Comparisons in Outcome Variables and Daily Mobile Media Use

	Media Use					
	Daily		Non-Daily		Comparisons	
Outcomes	*M* (*SD*)	*n*	*M* (*SD*)	*n*	*t* (df)	*p*
BRIEF-P Global	47.23 (9.48)	14	51.22 (10.07)	18	1.09 (30)	.29
BRIEF-P EC	46.29 (6.70)	14	52.06 (8.77)	18	2.04 (30)	.05
NEPSY-II	9.25 (3.72)	12	7.88 (3.27)	17	-1.03 (27)	.31
Physical Act.	11.50 (5.17)	11	14.67 (5.65)	15	1.46 (24)	.16

Note. BRIEF-P EC = Emotional control on BRIEF-P. Physical Act = Physical activity.

Research Question 5: Does preschool children's sleep moderate the relationship between mobile media use and measured outcomes?

A hierarchical multiple regression was run to assess the statistical significance of the interaction term between sleep (in hours per night) and mobile media use (in minutes) on the measured outcome variables, while controlling for the child's gender. Normality was met as assessed by a visual inspection of the histogram and P-P Plot, and there was no evidence of multicollinearity as assessed by tolerance values ($p > .10$). There was homoscedasticity, as assessed by a visual inspection of the standardized residuals plotted against the predicted values (i.e. the data was randomly scattered with approximately constant spread). Given the small sample size, linearity was difficult to assess, thus results should be interpreted with caution. As shown in Tables 12-15, the interaction between sleep and mobile media use (in minutes) did not explain significant variance in the NEPSY-II score, $F(4, 28) = 2.73$, $p = .11$, $R^2\Delta = .08$, global BRIEF-P global executive score, $F(4, 31) = .01$, $p = .94$, $R^2\Delta = .00$, emotional control, $F(4, 31) = .01$, $p = .95$, $\Delta R^2 = .00$, or physical activity, $F(4, 25) = 0.25$, $p = .62$, $\Delta R^2 = .01$.

Table 12

Summary of Moderation Regression Analysis for Variables Predicting the NEPSY-II

	Model 1			Model 2			Model 3			Model 4		
Variable	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Child's Gender	-2.90	1.22	-.42	-2.90	1.25	-.42	-2.88	1.30	-.41	-2.04	1.35	-.29
Sleep				.00	.94	.00	.03	1.00	.01	.01	.97	.00
Media Duration							.00	.03	.02	.07	.05	.40
Media Duration x Sleep										1.53	.92	.47
R^2	.17			.00			.00			.08		
F for change in R^2	5.70			.00			.01			2.73		

Table 13

Summary of Moderation Regression Analysis for Variables Predicting BRIEF-P Global

	Model 1			Model 2			Model 3			Model 4		
Variable	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Child's Gender	6.60	3.33	.34	7.87	3.32	.41	7.57	3.45	.39	7.69	3.86	.40
Sleep				-3.93	2.30	-.29	-4.24	2.46	-.32	-4.22	2.51	-.31
Media Duration							-.03	.09	-.07	-.03	.14	-.06
Media Duration x Sleep										.19	2.59	.02
R^2	.12			.08			.00			.00		
F for change in R^2	3.91			2.93			.16			.01		

Table 14

Summary of Moderation Regression Analysis for Variables Predicting Emotional Control

	Model 1			Model 2			Model 3			Model 4		
Variable	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Child's Gender	5.65	2.82	.34	6.54	2.89	.40	5.51	2.84	.34	5.59	3.17	.34
Sleep				-2.75	2.00	-.24	-3.80	2.02	-.33	-3.80	2.07	-.33
Media Duration							-.12	.07	-.30	-.11	.12	-.28
Media Duration x Sleep										.13	2.13	.02
R^2	.12			.06			.07			.00		
F for change in R^2	4.02			1.95			2.71			.00		

Table 15

Summary of Moderation Regression Analysis for Variables Predicting Physical Activity

	Model 1			Model 2			Model 3			Model 4		
Variable	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Child's Gender	.14	2.26	.01	1.08	2.38	.10	1.00	2.43	.09	.32	2.83	.03
Sleep				-1.96	1.68	-.25	-2.36	1.95	-.30	-3.01	2.37	.03
Media Duration							-.03	.06	-.10	-.10	.16	-.41
Media Duration x Sleep										-1.51	3.00	-.29
R^2	.00			.06			.01			.01		
F for change in R^2	.00			1.36			.19			.25		

CHAPTER 5

DISCUSSION

Understanding preschool children's mobile media habits and how it contributes to development is critical as the popularity and availability of mobile devices is vastly increasing (Rideout, 2017). Not only are mobile devices trendy in adults and adolescents, but many children are also given access to mobile devices in their preschool years (Kabali et al., 2015). However, relatively little research has explored mobile media use in early childhood, despite findings that TV viewing is connected with cognitive, academic, and social-emotional delays (American Academy of Pediatrics, 2016; Lillard & Peterson, 2011; Rosenqvist et al., 2016). Therefore, the purpose of this study was to explore how much time children are spending on screen devices, what devices they are most commonly using, and how mobile media use relates to executive functions, physical activity, and sleep. The following discussion addresses the main findings of the study, a comprehensive discussion of implications of the findings, followed by a review of limitations, considerations for future research, and concluding thoughts.

Screen Time in Preschool Children

Overall, the descriptive results of this study show that, whether they are aware of the guidelines or not, parents in this study are following many screen time recommendations released by digital experts (American Academy of Pediatrics, 2016; Canadian Pediatric Society, 2017). Although the children in this study were exposed to many screen devices in their home, child ownership and bedroom devices were limited, and this may help discourage excessive screen use by limiting ready access (Kabali et al., 2015). Moreover, it was reported that most preschool children in this sample still needed some help navigating a mobile device, which is reassuring given that parent's assistance using a mobile device helps encourage that children are

viewing educational content (Canadian Pediatric Society, 2017; Kabali et al., 2015). Correspondingly, almost all parents had household rules about screen time. Prior research has shown that enforcing rules regarding screen use helps protect children from excessive use and inappropriate content (Hoyos, Cillero, & Jago, 2010). In addition, the average age of first using a mobile device was around age three and a half ($M = 3.42$), and although this was limited specifically to using a mobile device, parents from this study appear to be following recommendations by discouraging screen use before the age of 2 years old (American Academy of Pediatrics, 2016; Canadian Pediatric Society, 2017).

In regards to what activities children are doing on a mobile device, this study found that children mainly use mobile devices to watch videos, play games, or look at different things. Several studies have explored how different screen content affects children's learning and cognition. For instance, active screen activities (e.g., playing games) may be more beneficial for children's cognitive functioning compared to passive screen activities (e.g., watching TV; Huber et al., 2018; Nathanson & Beyens, 2018a). However, some research suggests that watching educational videos may be beneficial for learning and cognition (Rosenqvist et al., 2016).

Exploring when children are using mobile devices, this study found that parents most commonly let their child use a mobile device when doing chores around the home. This finding is similar to previous research, which suggests that parents are using mobile devices as "digital pacifiers" to manage behavior or keep their child occupied (Kabali et al., 2015; Rideout, 2013). Indeed, a qualitative study by Bentley, Turner, and Jago (2016) stated that mothers mentioned the convenience of having a portal device to distract their child in various situations.

Overall, an encouraging result of this study is that the preschool children are meeting screen time recommendations released by the Canadian Pediatric Society (2017) and the

American Academy of Pediatrics (2016), both of which recommend that children under 5 years old should not exceed more than one hour of screen time a day. Although the majority of children in this study are watching TV daily (90.6%) and a large minority are using a mobile device daily (43.8%), they are spending an average of 34 minutes per day using any screen device.

The parent-reported screen times (in minutes) are notably lower than that found by previous research findings, where many studies find that preschool children are exceeding one hour of screen time per day (Kabali et al., 2015; Rideout 2017; Xu et al., 2016). Indeed, the present study found that children were reported to spend almost two hours per day less using screen devices compared to the most recent study by Common Sense Media (i.e., 33.75 minutes vs. 139 minutes; Rideout, 2017). Additionally, children in this study were reported to use mobile devices 38 minutes per day less compared to Common Sense Media results (i.e., 10.31 minutes vs. 48 minutes; Rideout, 2017).

There are several possible reasons for the discrepancy in media use found in this study compared to previous research (Kabali et al., 2015; Rideout 2017; Xu et al., 2016). First, the participants from this study are not representative of preschool population across Canada, nor were they representative of participants from previous research. For instance, the participants from Kabali et al.'s (2015) study were predominately minorities from a lower socioeconomic status, whereas the majority of participants from this study were Caucasian (78.1%) and most mothers had a university degree or higher (71.9%). Previous research has found that children from a lower socioeconomic status spend more time watching TV (Levin, Martin, & Riner, 2004; Loprinzi, Schary, & Cardinal, 2013), and parents with a higher education feel more confident occupying their children with non-screen time activities (Njoroge, Elenbaas, Garrison,

Myaing, & Christakis, 2013). Additionally, almost all parents in this study have household rules regarding screen time. As aforementioned, monitoring screen use has been associated with lower screen time for children (Hoyos et al., 2010; Lampard, Jurkowski, & Davison, 2013). For instance, a study conducted by Lampard et al. (2013) found that parent's self-efficacy about restricting screen time was associated with greater reduction of child's screen time. Additionally, the limited exposure children have to owning their own device or having a device in their bedroom may account for the lower screen duration. Indeed, research has found a positive association with bedroom devices and overall screen time in children (Lee, Kubik, & Fulkerson, 2018; Tandon et al., 2014). Taken together, these individual differences may explain the discrepancy in screen time from this study compared to others (i.e. Rideout, 2017), and consequently the results of this study are difficult to generalize to preschoolers across Canada.

Additionally, caution should be warranted for relying on one parent to provide all information about a child's behavior. First, parents may be responding to their child's screen habits in a socially desirable way and therefore reporting less screen time. In survey research, it is possible for participants to respond in a way that they believe is more socially accepted rather than responding truthfully (Gittelman et al., 2015). Second, children can often use mobile media devices in short periods of time throughout the day and it is possible that parents did not accurately account for total screen time. Although questions on screen time were asked about "yesterday" to help increase reliability, using a time dairy may have strengthen reliability and control for recall bias (Nathanson & Beyens, 2018a). Thirdly, rather than collecting information from multiple sources, this study relied on information from one informant. Given that many children spent time in daycare or preschool, it is possible that children's screen consumption may be underreported.

Consistent with past research, the current study found that TV was the most commonly used screen device, followed by mobile devices, and finally by computers (Rideout 2017). These results follow a similar trend found by the Common Sense Media studies, which indicated that over the years, children spend most time watching TV, and most recently, mobile devices are the second most utilized screen platforms used by young children (Rideout, 2017). With the exception of TV viewing, this research shows that traditional screen devices such as computers and video games are becoming less popular to young children compared to mobile devices.

Correlations Amongst Child Demographics, Mobile Media Use, and Outcome Variables

Sedentary behavior, physical activity, and executive functioning are complex variables that are influenced by interacting contextual factors, which can either hinder or facilitate behaviors and performance (Lindsay et al., 2017). Given the importance of physical activity, executive functioning, and limiting screen time in early childhood, early influences of these behaviors were explored. Of note, this study found a significant and negative correlation between the child's age and parent-reported physical activity, indicating that as a child's age increases, their reported amount of physical activity a week decreases. This finding is consistent with numerous other research studies, showing a concerning trend that physical activity levels decrease with age (ParticipACTION, 2016; Taylor, Williams, Farmer, Taylor, & Bacurau, 2013). The ParticipACTION report card from 2016 indicated that 70% of 3-4-year-old children met physical activity guidelines, while only 9% of 5-17 year-olds met guidelines (ParticipACTION, 2016). Although there is no one conclusive reason for this age disparity, starting school and increased sedentary time have shown to be contributing factors (Santos et al., 2018; Taylor et al., 2013).

In this study, the child's age also negatively correlated with the global executive composite score on the BRIEF-P, meaning that as age increased there were less reports of problematic executive function behavior. This resonates with general neurological development, as a child's age increases so does their brain development and behavioral maturity (Anderson & Reidy, 2012). However, an interesting finding of this study is that as the parent education level increased, the higher the rated problem with emotional control. This finding differs from previous results with studies using the BRIEF (Gioia et al., 2003), which found as the parent education level increased, the child's executive function behaviors were rated less problematic. The BRIEF-P professional manual does state that parent education level should not be considered a major factor in the interpretation of the scores, given that parent's education level only accounted for 5% of the variance in the scores in their standardization procedure (Gioia et al., 2003).

Another interesting finding was that as hours in daycare each week increased, the child's sleep per night (in hours) decreased. Indeed, other researchers have sound similar relationships between daycare and sleep (Bordeleau, Bernier, & Carrier, 2012; Yokomaku et al., 2008). For example, Bordeleau et al. (2012) found that children in daycare slept less at night, but tended to sleep more over a 24-hour period. Perhaps children are taking nap periods during daycare so they need less sleep at night, or they are not tired before bed, so they are put to bed later or waken up earlier (Bordeleau et al., 2012; Yokomaku et al., 2008). Indeed, a study by Staton, Smith, Pattinson, and Thorpe (2015) found that children who were exposed to more than 60 minutes of napping at daycare had significantly less sleep duration at night.

Additionally, the results of this study show that females performed significantly higher on the NEPSY-II than males, and males had significantly higher reports of problematic

emotional control. Previous researchers have also shown such gender discrepancies in neurological assessments (Mous et al., 2017); Mous and colleagues (2017) and Sevadjian (2014) both found that girls over the age of five performed better on the NEPSY-II attention and executive functioning domains compared to boys. Klenberg, Korkman, and Lahti-Nuuttila (2001) also found that preschool females made fewer errors on the NEPSY-II compared to males. Research by Klenberg et al. (2001) suggest that inhibition and impulse control mature earlier in girls, hence why they are performing better; or this sex difference may be an explanation of attentional disorders. Although it is acknowledged in the literature that neurocognitive abilities differ between males and females, and that attention problems are more prominent in males, differences in performance is both influenced biologically and socially (Sevadjian, 2014). Therefore, the relationship between biology and environmental contributions should be considered in the interpretation of this finding.

Mobile Media Use and Executive Functioning

In regards to mobile media use, the results of the present study showed that children who used mobile devices daily had less problematic ratings of emotional control compared to children who did not use mobile devices daily. Nathanson and Beyens (2018a) found that watching videos on a tablet was negatively correlated with effortful control (another form of self-regulation), while hand-held game playing positively correlated to effortful control. Similarly, Huber et al. (2018) found that playing with educational apps benefited preschool children's executive function performances more than watching a cartoon. Comparable results are found in older research exploring traditional screen devices that generally show that active screen use, such as playing video games, aids cognitive performances (Christakis et al., 2013; Rosenqvist et al., 2016).

First, it is possible that children with poor emotional control may have excessive and unpredictable emotional reactions. Given that many activities on mobile devices require concentration, attention, and alertness, parents may only be supplying these devices to their child in a calmer state (Nathaonson & Beyens, 2018a). This claim is supported by a qualitative research study by Bentley and colleagues (2016) who found that mothers predominately used mobile devices as a reward for their child's good behavior. Contrary, it is possible that parents may be supplying their child with mobile devices in an attempt to soothe emotional reactions. As mentioned above, parents sometimes use mobile devices as digital pacifiers to manage their child's behavior (Kabali et al., 2015; Rideout, 2013). Qualitative research findings by Holloway, Green, and Love (2014) indicate that children demonstrate strong reactions when denied screen access; for example, one parent stated "He also throws himself on the floor and wails inconsolably when he's denied anything, such as…the iPad" (Holloway et al., 2014). Hence, parent's who are not allowing their child to use mobile devices may be subjected to more emotional outbursts.

Additionally, greater focus has been recently given on the content of screen use rather than the device itself, suggesting that one of the main focuses should be choosing educational and interactive screen contents and avoiding mainstream, commercial programming (Canadian Pediatric Society, 2017). In the present study, most mothers rated educational value as their first consideration when letting their child use different apps. Therefore, it is possible that children are viewing more educational content when using mobile devices, thus aiding cognitive performance.

The present study found no significant difference between children's screen use and performance on inhibition as measured by the NEPSY-II. This finding is consistent with Huber

and colleagues (Huber et al., 2018) who also found no significant association between screen time and inhibition in preschool children. Although it is not clear exactly why this is the case, an explanation may be the validity and/or reliability of the measurement tool itself. It is difficult to get valid measures of executive functions using standardized assessments, considering preschool children get tired and easily distracted (Anderson & Reidy, 2012). In the case of the present study, the children were administered this task in varying settings (e.g., their home, library) with fluctuating noise levels and distractions, and these contextual issues may have impacted standardization and resulted in lowered scores. In other words, this measure of inhibition may be less reliable than a behavioral report.

Mobile Media Use and Physical Activity

This research found no significant relationship between mobile media use and physical activity. Although some research has found that increased screen time is related to lower levels of physical activity, most researchers suggest that this relationship is confounded by other factors, such as age and socioeconomic status (Dawson et al., 2015; Lindsay et al., 2017). Most young Canadian children are meeting physical activity recommendations, and children from a higher socioeconomic status are more likely to be physically active (Chaput et al., 2017; Lindsay et al., 2017), suggesting that most children in this study are participating in sufficient amounts of physical activity a day. Indeed, approximately 79% of parents reported that their child receives enough physical activity.

Mobile Media Use and Sleep

Sleep duration (hours per night) was not found to be a significant moderator between mobile media use (i.e., minutes) and the child-administered measure of executive functioning or physical activity. Additionally, results indicated that the inclusion of the child's gender (as a

covariate) in the regression analysis accounted for 12-17% of the variance in executive functioning outcomes. In the development of the BRIEF-P, Gioia et al. (2003) found that in the parent-rating scales, boys were reported to have more difficulties with inhibition. In the teacher rating scales, boys were found to have higher ratings of problematic global executive functioning. This is similar to other research that found preschool girls outperformed boys in executive functioning measures (Mileva-Seitz et al., 2014) and that young boys exhibit more behavioral difficulties than girls (Kraemer, 2000).

However, after controlling for gender, it was expected that children who slept less would exhibit more problematic executive functioning behaviors and have less energy for physical activity (Hinkley et al., 2012; Karpinsk et al., 2008; Nelson et al., 2015). However, all preschool children in the current sample were meeting sleep recommendations between 10-12 hours per night (Tremblay et al., 2017), which may have countered any negative effects of mobile media use. Additionally, almost all children did not have access to any screen device in their bedroom, likely preventing excessive screen exposure (Mindell et al., 2009). Another explanation for this insignificant finding is that almost all of the parents did not allow their child to use a mobile device to fall asleep. Numerous studies have shown that nighttime screen use is associated with poorer sleep outcomes in young children (Garrison, Liekweg, & Christakis, 2011; Nathanson & Beyens, 2018b). Therefore, while the children in this study all received adequate amounts of sleep and had healthy sleep habits, this may have protected them from any effects of mobile media use.

Implications

One of the riches of this research is the extensive descriptive information obtained from parents regarding screen practices in the home. Understanding the adoption of screen devices in

early childhood is an essential first step in exploring how screen time relates to child development and to enforce healthy practices. Additionally, screen use at this age may be habit-forming for later stages of life and healthy family routines are more easily established in this age group (Canadian Pediatric Society, 2017). Therefore, these descriptive results add to a growing body of literature exploring what screen activities children are engaging in and for how long.

This study also examined what demographic characteristics relate to mobile media use, physical activity, sleep, and executive functioning. In regards to age, this study found a negative correlation between age and physical activity. It is well established in the literature that physical activity tends to decline with age (ParticipACTION, 2016). Therefore, it is recommended that parents ensure physical activity behaviors are incorporated into children's daily life (Lindsay et al., 2017). Although this study did not find any relationship between mobile media use and physical activity, this is inconsistent with other research findings, and therefore, it is still recommended that excessive sedentary behavior be discouraged (Canadian Pediatric Society, 2017; Lindsay et al., 2017).

As one of the only studies that examined the relationship between mobile media use and measured child developmental outcomes, this study worked on the premise that traditional screen devices (e.g. TV) have been examined as potentially harmful in cognitive development (Cespedes et al., 2014; Lillard & Peterson, 2011; Wu et al., 2016). Extending from this work, the results of this study provide evidence that mobile media use may not be hindering child's cognitive functioning. Indeed, this study found that daily mobile media use was related to better parent-rated emotional control. However, the discrepancy in the literature on traditional screen sources and mobile media may be a result of the content itself. For instance, active screen activities (e.g. playing games) and educational programming may be more beneficial for

children's cognitive functioning and learning compared to passive screen activities (Huber et al., 2018; Nathanson & Beyens, 2018a; Rosenqvist et al., 2016). Therefore, it is recommended that parents and educators monitor what activities children are viewing on any screen device and choose educational content (Canadian Pediatric Society, 2017).

Limitations and Future Research

Conducting an exploratory study in a new area of research comes with various limitations. To begin, one of the primary limitations of this study was the small sample size. Having a small sample size limits the statistical power, making it difficult to find large effects (VanVoorhis, & Morgan, 2007). Additionally, having a small sample size and running multiple analyses increases the risk for Type 1 Error, such that one rejects the null hypothesis when in reality, the null hypothesis is true (i.e., a false positive), ultimately undermining the reliability of the results (Voorhis, & Morgan, 2007). The small sample size of this study is largely explained by a low response rate to participate, limited financial resources, and time commitment to recruit more participants. In regards to the low response rate, it is possible that parents were deterred from this research given the commitment to complete an online survey and meet in person with the researcher for the child assessment component of the study.

Another caveat of this research is the cross-sectional design and measures used in this study. Cross-sectional research limits children's behavior to a one-time period, which does not allow researchers to determine cause and effect. A limitation of this method was asking parents to exclusively report on their child's previous day media use, rather than spreading it out over several days to limit any bias towards weekdays or weekends. However, reports on behavior from a recent time period (i.e. last 24 hours) helps to reduce recall error and improve the reliability of report (Araujo, Wonneberger, Neijens, & de Vreese, 2017; Kabali et al., 2015).

Overall, understanding the prevalence of screen use in children is beneficial for public health, educational, and research information. Additionally, the timing of this period may not be representative of children's true behavior. For example, physical activity levels may be higher in warmer months, or executive functioning may differ if the child is sick or tired. Future work may wish to consider collecting data at multiple time points and more longitudinal research is needed to determine how these relationships change over time.

In regards to the measures used in this study, the screen time survey and physical activity questionnaire used have no published evidence of validity or reliability. The physical activity questionnaire asked parents to indicate the number of times per week their child engages in physical activity, which may have resulted in a misrepresentation of children's true physical activity levels, given parent's recall bias, possible over estimation of physical activity, and fluctuating levels of physical activity each week. Experimental research using a more reliable and valid measure of physical activity (e.g., accelerometer) is needed to better understand this relationship. Nonetheless, these measures still provided useful information for clinical and research purposes. Additionally, another strength is using both a standardized assessment of executive function for an objective measure and a parent-rating measure for a behavioral report.

Lastly, although this research found that mobile media use fostered emotional control, other research has found that passive media sources such as watching videos or TV hinders executive functioning in preschool children (American Academy of Pediatrics, 2016; Huber et al., 2018). Given these disparities, future research should continue to explore this relationship. It is recommended that researchers continue to study the effect of mobile media in early childhood, and explore how screen content affects children's learning and executive functioning.

Conclusions

As young children learn and grow in a world immersed with mobile devices, it is the responsible of those who work with children to accurately provide guidance on healthy screen use. School psychologists should educate the school community and parents on the positive and negative effects of mobile media use on children's academic lives (Savina et al., 2017). The significant relationship between daily mobile media use and emotional control may suggest that active screen activities enhance cognitive performances.

Nevertheless, research on screen time's impact on child development is continuing to grow. This research provides value in understanding the exposure and patterns of screen use in this population. It is promising that parents from this study appear to forming healthy screen time habits in their children. However, this may not be the case in other populations. This study would benefit from replicating and expanding to a larger, diverse population. Understanding screen time practices is one of the first steps in addressing the impact on development, which will also help guide recommendations for health care providers and families.

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Appendix A: Physical Activity Guidelines

The Canadian Society for Exercise Physiology newly released 24-Hour Movement Guidelines to encourage Canadians to live an active lifestyle with balanced physical activity, sedentary behaviors, and sleep (Tremblay et al., 2017). CSEP recommends that preschooler's ages 3-4 years old should accumulate 180 minutes of physical activity each day, and at least 60 minutes should be energetic play. Energetic play refers to moderate to vigorous activity such as bike riding, playground activities, running, and swimming (Tremblay et al., 2017).

By the time children reach the age of 5 years old, it is recommended that a child spend 60 minutes per day of moderate to vigorous physical activity (CSEP, 2016). Moderate activity is defined as physical activity that is performed 4.0-6.9 times the intensity of rest for children. This includes active transportation, recreational activities such as hiking and rollerblading, and playing games that require catching and throwing (CSEP, 2016) Vigorous activity is performed 7.0 or more times the intensity of rest for children and can include running, chasing, jumping, sports, vigorous dancing, and aerobics (CSEP, 2016). Vigorous activities and muscle and bone strengthening activities (e.g. climbing, lifting, resistant exercises) should be incorporated at least 3 days per week for 5-year-old children (CSEP, 2016).

Appendix B: Recruitment Poster

Appendix C: Demographic Questions

Please provide the following information about yourself:

1. What is your age:

2. What is your gender:

3. What is your ethnicity:
- Aboriginal/First Nations
- Asian or Pacific Islander
- Black or African American
- Hispanic or Latino
- White/Caucasian
- Prefer not to answer

4. What is your relation to your child:
- Mother
- Stepmother
- Grandmother
- Aunt
- Guardian
- Other

5. Are you currently employed?
- Yes, full-time
- Yes, part-time
- No
- Other

6. What is your highest level of education?
- High School
- Technical Diploma
- University Degree (e.g. Bachelors)
- Graduate Degree (e.g. Master's, PhD)
- Professional Degree (e.g. MD, JD)
- I am currently a student

7. Which choice best described your family structure with respect to parent(s) living in the home?
- Two-parent household (all family members biologically related)
- Two-parent household (step-family, with child from one or both parents)
- Two-parent household (blended family, with children from one or both parents and new children)

- Two-parent household (with adopted children, or some combination of adopted children and/or biological children)
- Two-parent household (same gendered-parents, with any combination of adopted children and/or biological children)
- Single-mother household
- Single-father household
- Other

8. Besides the child your filling out this survey for, are there any other children living in the household?
- Yes (please include their relationship with your child, age, and gender)
- No

Please complete the following questions about your child:

1. What is your child's birth date:

2. What is your child's gender?

3. What is your child's ethnicity:
- Aboriginal/First Nations
- Asian or Pacific Islander
- Black or African American
- Hispanic or Latino
- White/Caucasian
- Prefer not to answer

4. Does your child spend any time at an early childhood education center or day care?
- Yes (how many hours per week?)
- No

5. Has your child experienced any frequent or significant illnesses (asthma, diabetes, heart disease, etc.)?
- Yes (please explain)
- No

6. Has your child ever used any medication for any extended period of time or is your child using any medication currently?
- Yes (please explain)
- No

7. Are you concerned about your child's eating habits?
- Yes (please explain)
- No

Appendix D: Screen TIme Questionnaire

(Kabali et al., 2015)

Which of the following, if any, due you have in your household? (Please select all that apply).

- ☐ TV set
- ☐ Desktop computer
- ☐ Laptop computer
- ☐ Internet access
- ☐ Smartphone (a type of cellphone that you can use for internet access)
- ☐ Apple iPod Touch or other type of iPod
- ☐ Tablet
- ☐ Kindle eBook reader
- ☐ Xbox
- ☐ PlayStation
- ☐ Nintendo
- ☐ None
- ☐ Other (please specify)

Which of the following, if any, is your child allowed to keep in his/her bedroom (Please select all that apply).

- ☐ TV set
- ☐ Desktop computer
- ☐ Laptop computer
- ☐ Internet access
- ☐ Smartphone (a type of cellphone that you can use for internet access)
- ☐ Apple iPod Touch or other type of iPod
- ☐ Tablet
- ☐ Kindle eBook reader
- ☐ Xbox
- ☐ PlayStation
- ☐ Nintendo
- ☐ None
- ☐ Other (please specify)

We are interested in whether your child has ever used a mobile device to do any of the following activities (example of mobile devices are smartphones, iPods, laptop, kindle eBook reader, iPad, kid's talbets). Please mark all activities your child has ever done:

- ☐ Touch or scroll the screen to look at different things
- ☐ Watch videos
- ☐ Watch TV shows
- ☐ Play games
- ☐ Listen to music
- ☐ Use other apps
- ☐ None
- ☐ Other (please specify)

We are interested in how often your child does various activities: (Please select one answer for each)

	Several times a day	Once a day	Several times a week	Once a week	Less than once a week	Never
Read or be read to	☐	☐	☐	☐	☐	☐
Watch TV	☐	☐	☐	☐	☐	☐

Use a laptop or desktop computer	☐	☐	☐	☐	☐	☐
Play video games on a console player	☐	☐	☐	☐	☐	☐
Play games, use apps, or watch videos on a smartphone, iTouch or iPod, iPad, or other tablets	☐	☐	☐	☐	☐	☐

How old was your child when he/she FIRST did various activities on a mobile device?

	Less than 1 year old	1 year old	2 years old	3 years old	4 years old	5 years old	Never
Watched TV shows	☐	☐	☐	☐	☐	☐	☐
Called someone	☐	☐	☐	☐	☐	☐	☐
Touched or scrolled to look at different things	☐	☐	☐	☐	☐	☐	☐
Played video games	☐	☐	☐	☐	☐	☐	☐
Used apps	☐	☐	☐	☐	☐	☐	
Other activities	☐	☐	☐	☐	☐	☐	

Does your child need any help to navigate the smartphone, iPod, laptop, iPad, tablets or similar devices?

- ☐ Always
- ☐ Sometimes
- ☐ Never

Thinking about YESTERDAY, about how much time (in HOURS), if any, did your child spend by him/herself doing the following activities?

	None	Less than 30 mins	About 30 minutes	About 1 hour	More than 1 hour
Being read to	☐	☐	☐	☐	☐
Listening to music	☐	☐	☐	☐	☐
Physical activity (playground, play with other children, play with toys)	☐	☐	☐	☐	☐
Playing games on a video console	☐	☐	☐	☐	☐
Use other type of apps on mobile device	☐	☐	☐	☐	☐
Watch TV	☐	☐	☐	☐	☐
Watching videos or TV shows on a mobile device	☐	☐	☐	☐	☐

How often do you let your child play with video games, laptops, smartphones, iPod's, iPad's, tablets, or similar devices? (Check one option on each row)

	Often	Sometimes	Hardly Ever	Never
When you are out running errands?	☐	☐	☐	☐
When you do chores around the house?	☐	☐	☐	☐
Keep child calm in public gatherings?	☐	☐	☐	☐

Put child to sleep?	☐	☐	☐	☐
Other (please specify)				

How often does your child like to use more than one type of media device at a time? For example, play with a cell phone while he/she is watching TV or listen to music while he/she is using the tablet?

- ☐ Most of the time
- ☐ Some of the time
- ☐ Only once in a while
- ☐ Never

Approximately how many apps have you downloaded into your smartphone, iPod, laptop, kindle, iPad, tablet or similar device?

- ☐ None
- ☐ Fewer than 5
- ☐ 5-10
- ☐ 10-20
- ☐ 20-30
- ☐ More than 30

Approximately how many of the apps that you have downloaded are for your child's use?

- ☐ Most of them
- ☐ About half of them
- ☐ Less than half of them
- ☐ Only a few
- ☐ None

We are interested to know if your child has his/her own: (please check all that apply)

- ☐ TV set
- ☐ Desktop computer
- ☐ Laptop computer
- ☐ Internet access
- ☐ Smartphone (a type of cellphone that you can use for internet access)
- ☐ Apple iPod Touch or other type of iPod
- ☐ Tablet
- ☐ Kindle eBook reader
- ☐ Xbox
- ☐ PlayStation
- ☐ Nintendo
- ☐ None
- ☐ Other (please specify)

How do you choose what Apps your child plays? (rank)

- ☐ Educational value
- ☐ Price
- ☐ Attraction

Thinking about yesterday, how much time did you spend doing the following activities at home (not working)?

	5-30 mins	30-60 mins	1-3 hours	3+ hours	I do not own this device
On the computer	☐	☐	☐	☐	☐
On the internet	☐	☐	☐	☐	☐
On a smartphone	☐	☐	☐	☐	☐
On a tablet	☐	☐	☐	☐	☐

Do you have household rules about screen time and use (how much time, what shows/websites, types of video games)?

☐ Yes
☐ No

How do you enforce the rules regarding your child's screen time and use?

☐ I limit the amount of my child's screen time
☐ I use control or software blocks on the internet/television
☐ I check the search/website history regularly on my child's home technology
☐ I ask my child to leave their screen outcome their bedroom
☐ I remove screen privileges for inappropriate use, overuse, or failure to follow rules
☐ Other

☐ **How often does your child follow the rules regarding screen time and use?**

☐ Often
☐ Sometimes
☐ Hardly Ever
☐ Never

Appendix E: Physical Activity Questionnaire

How many hours per day does your child spend doing the following activities outside of child care, preschool, or school? (Please answer separately for weekdays and weekends)"

Unstructured play (for example, playing with toys, doing a craft, playing ball)?

	None	Less than 1 hour/day	1-2 hours/day	3-4 hours/day	5+ hours/day
On weekdays					
On weekends					

How many hours per week does your child have lessons or instruction in organized physical activities with a coach or instructor (such as dance, gymnastics, or martial arts)?

In the past month, how often did your child engage in the following types of physical activities in their typical week?
***Indicate times per week**

Mild activity (e.g. light waking for at least 15 minutes)

Moderate activity (e.g. brisk walking for at least 15 minutes)

Strenuous activity (e.g. running for at least 15 minutes)

My child:

- □ Needs more physical activity
- □ Gets enough physical activity