

## **Introduction**

The National Sleep Foundation suggests preschoolers need 10-13 hours of sleep per night (Hirshkowitz et al., 2015). Many children fail to reach this recommendation; estimates of the prevalence of sleep problems in young children range from 15% to 40% (Mindell et al., 2013; Mindell et al., 2010, Wong et al., 2013). A population-based study in the U.S. shows approximately 30% of preschoolers do not get as much sleep as they may need (National Sleep Foundation, 2004). Studies of younger children in the U.S. suggest that low-income children spend more time in front of screens than higher-income children (Anderson & Whitaker, 2010; Certain & Kahn 2002; Common Sense Media 2011; Sisson et al., 2009). Studies show that children of all ages from low-income and non-White families in the U.S. are at even higher risk for short sleep duration (Eaton et al., 2007; McDonald et al., 2014; Moore et al., 2011; Moran & Evarhard, 2012; Sheares et al., 2013; Wong et al., 2013) and adverse health outcomes associated with lack of sleep (National Center for Health Statistics, 2016). Short sleep duration is associated with higher risk for obesity (Capuccio et al., 2008; Jiang et al., 2009), externalizing behaviors (Barlett et al., 2012; Sadeh, 2007; Scharf et al., 2013; Touchette et al., 2007), emotion regulation (Barlett et al., 2012; Berge et al., 2012; Sadeh, 2007; Scharf et al., 2013; Touchette et al., 2007), and lower school readiness (Duncan et al., 2007; Tso et al., 2016).

Increased screen time is linked to shorter sleep duration and lower quality of sleep (Falbe et al., 2015; Garrison & Christakis, 2012; Magee, Lee, & Vella, 2014; Thompson & Christakis, 2005). Screen time reduction has been used as an intervention method for improving sleep

This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: [10.1111/cch.12869](https://doi.org/10.1111/cch.12869)

quantity and quality and has demonstrated a media use intervention can improve sleep outcomes in preschool age children (Garrison & Christakis, 2012). The American Academy of Pediatrics (AAP) recommends one hour a day of high-quality screen time programming for children ages 2-5. Studies show many children are consuming up to twice these guidelines (Atkin et al., 2014; Bar-On et al., 2001; Tandon et al., 2011). This may be due to an increasing availability of screen-based media to children in the forms of TV, phone games, online streaming services, video game, and hand-held consoles (Atkin et al., 2014).

Though there is a link between screen time use and sleep symptoms in youth, there is a lack of research among minority and low-income preschool populations in the U.S. This study is a cross-sectional examination of the association of screen time and sleep symptoms among a sample of 1,628 children in preschools in Metro Detroit recruited to a larger trial of 4,845 children. Using parent report baseline we examined the association of screen time and quality of sleep, tiredness during the day, and child's ability to fall asleep.

## **Methods**

### **Participants**

A post hoc analysis was conducted using baseline cross-section data that was collected over 2 years of recruitment from a larger nutritional intervention trial at inner-city preschools in the Metro Detroit area of Michigan. Baseline data for this study was collected from October

2013 - June 2014, and October 2014 - June 2015. Preschools were Head Start programs and Great Start Readiness Programs (GSRP) serving parents meeting federal Poverty Guidelines and families who were homeless, in foster care, or received other forms of public assistance (Benefits.gov, 2016). Families who did not meet eligibility requirements for Head Start but were still considered low-income were referred to GSRP.

### **Trial Design**

This study was part of a larger intervention trial to evaluate Regie's Rainbow Adventure<sup>®</sup>, a seven week nutrition and physical activity intervention for 3-5 year old children implemented by teachers within Head Starts and GSRPs. The trial was evaluated using a quasi-experimental design. Data used in the analyses reported here comprise the baseline assessment only, from intervention and comparison sites in the larger trial. After the seven weeks, follow-up data was collected using the same survey tools from the baseline assessment. No follow up data was included in this study's analyses. Variables of interest for analyses were trouble falling asleep, quality of sleep, tiredness, and weekly screen time. Body mass index (BMI) was measured in a subset of the cohort and used as a covariate.

### **Trial Background and Funding**

Nearly three-quarters of kidney failure caused by diabetes or high blood pressure could be prevented or delayed by eating healthy, getting exercise, and taking the right medications. The NKFM is committed to preventing kidney disease in young children through nutrition and physical education programs to encourage the development of healthy habits that can be maintained across the life course. The National Kidney Foundation of Michigan (NKFM) was awarded a Social Innovation Fund (SIF) subgrant from United Way for Southeastern Michigan, which the NKFM used to plan, recruit for, conduct, and analyze data from the trial. [The SIF was a program of the Corporation for National and Community Service (CNCS) that received funding from 2010-2016. Using public and private resources to find and grow community-based nonprofits with evidence of results, SIF intermediaries received funding to award subgrants that focus on overcoming challenges in economic opportunity, healthy futures, and youth development. CNCS made its last SIF intermediary awards in fiscal year 2016.]

### Sample

Data were collected from parents of 3-5 year olds who attended 42 Head Starts and GSRPs. Survey data was available for 1,628 study participants; BMI data was available for 1,076 participants. Parents completed paper surveys at tables staffed by NKFM employees who were available to answer questions. In year two of this 5-year long trial (first year of data for this article, October 2013 – June 2014), parents who completed both baseline and follow-up surveys entered into a raffle to win a Kindle Fire. In the third year of this study (second and final year of

data for this article, October 2014 – June 2015), parents received a \$5 gift card and raffle ticket for a \$500 gift card to a grocery store. The raffle pool included all parents who completed a survey. The incentive process was changed to increase response rate.

### **Ethical Approval**

This study was first approved by the Michigan Department of Community Health (MDCH) Institutional Review Board (IRB), who served as the IRB in year two of the trial. By the third year, the MDCH instilled a policy that only allowed them to serve as the IRB for programs to which they provided direct funding. As they did not provide funding to the NKFM, the NKFM applied for a new IRB and was accepted by ARGUS, who served as the IRB for the remainder of the study.

### **Study Measures**

#### *Demographics*

Demographics collected were age, sex, race/ethnicity, parental income, and parental education. These were chosen because of a known association with child health and well-being, of which sleep duration and quality is a part. Race was categorized into Black or non-Black. Ethnicity was categorized into Hispanic/Latino or non-Hispanic/Latino; these are the only subgroups for the ethnicity category. Parental education was divided into seven categories; some grade school, some high school, high school diploma/GED, trade certification, some college,

bachelor's degree, and graduate degree. Parental income was split into eight categories; less than \$10000, \$10001-\$15000, \$15001-\$20000, \$20001-\$25000, \$25001-\$35000, \$35001-\$45000, \$45001-\$60000, and greater than \$60000. Parental income was split into eight categories to glean a more nuanced understanding of sleep quality and duration as they relate to different levels of income within low-income families, and not just in juxtaposition to higher-income families.

### *Anthropometric Measures*

Baseline height (cm) and weight (kg) were collected by NKFM staff and converted to a BMI z-score based on the Centers for Disease Control 2000 age and sex specific growth charts (Centers for Disease Control [CDC], 2016). NKFM staff received a standard training on measuring children's height and weight. Children's shoes and heavy coats were removed; measurement was taken with their head, shoulders, buttocks, and heels touching the ruler. Height was rounded up to the nearest 1/8th of an inch and converted to centimeters for analysis. Weight was taken on digital scales, measured in pounds to the nearest 10th of a pound, and converted to kilograms for analysis.

### Sleep Symptoms

#### *Ability to Fall Asleep*

The survey asked “How often did your child have trouble falling or staying asleep in the past month?” using a Likert scale of Never, Rarely, Sometimes, Usually, Always, and Don’t Know. This question was created by combining two questions from the Sleep Disturbance Scale for Children (SDSC) (Bruni et al., 1996). The SDSC states “The child has difficulty getting to sleep at night” with answers being 1-Never, 2-Occasionally, 3-Sometimes, 4-Often, 5-Always and “After waking up in the night, the child has difficulty to fall asleep again” with the same possible answers (Bruni et al., 1996). This tool has been validated for use in determining sleep symptoms in children (Bruni et al., 1996).

### *Tiredness*

Parents were asked “In the past month, how often was your child tired during the day?” using a Likert scale of Never, Rarely, Sometimes, Usually, Always, and Don’t Know. This question was modified from the SDSC and Pediatric Sleep Questionnaire (PSQ). These tools have been validated for use in determining sleep symptoms in children (Bruni et al., 1996; Chervin et al., 2000). The SDSC states “The child experiences daytime somnolence” with answers being 1-Never, 2-Occasionally, 3-Sometimes, 4-Often, 5-Always (Bruni et al., 1996). The PSQ asks the question similarly: “Does your child have a problem with sleepiness during the day?” with answers being Yes, No, and I Don’t Know (Chervin et al., 2000). We included “I don’t know” as a response option to account for parents who engage in shiftwork and may not be awake during the day to monitor their child’s tiredness.

### *Sleep Quality*

Parents were asked “How would you rate the quality of your child’s sleep?” using a scale of Very Good, Fairly Good, Fairly Bad, and Very Bad. This was written by the study team to determine parents’ perceptions of their child’s sleep quality.

### Screen Time Measures

Total screen time was computed from two questions; how many hours the child spent watching television, and/or movies, and/or playing games (including X-box, PlayStation, Wii, Nintendo DS, tablet, iPad, and smartphone games) on a 1) typical weekday and 2) weekend day. Available responses were: Less than 1 hour/day, 1-2 hours/day, 2-3 hours/day, and More than 3 hours/day for each question. Weekday values were summed and then weighted (5 contributing scores for Monday-Friday), as were weekend values (2 contributing scores for Saturday-Sunday). Total weekly screen time for a child was measured in hours as follows:  $((\# \text{ of hours of screen time on a weekday} * 5) + (\# \text{ of hours of screen time on a weekend} * 2))$ . It was calculated in this way to account for the 5 weekdays and the 2 weekend days in a week.

### Statistical Analysis

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Data were reported as mean +/- standard deviation for normally distributed variables and median (interquartile range) for non-normally distributed variables. The non-normal screen time variable was square-root transformed and standardized to a mean of zero and standard deviation of one for all regression analyses. The relationships of screen time and sleep variables with demographic and anthropometric variables were assessed using mixed-effect models to account for clustering within the same center. Mixed-effect models were used to evaluate the relationships between screen time and sleep metrics after adjustment for age, sex, Black race, Hispanic/Latino ethnicity, parental education, and parental income, and to account for dependence of subjects from the same center through random effect. In the sub-analysis of individuals (n=1,076) with anthropometric data available, a BMI z-score was used. Model fit was evaluated by checking Studentized residuals for normality. One sensitivity analysis was performed in which an interaction term of BMI with screen time was included to determine if BMI modified the relationship between screen time and sleep. Unadjusted relationships of screen time and sleep variables with demographic and anthropometric variables were assessed by Spearman correlations. Statistical analyses were performed using SAS® software, Version 9.3 (SAS Institute, Cary), Copyright © 2011 SAS Institute Inc.

## **Results**

See Table 1 for participant characteristics. Mean age was  $4.36 \pm 0.58$  years. About half (51.2%) were male, a majority (73.2%) were Black, one fifth (20.33%) were Hispanic/Latino,

4.67% were White, and 1.72% were Asian. There were 20 mixed race (Hispanic/Latino-Black) children. Most children (72.1%) were from families that made less than \$20,000 per year. The average BMI z-score was  $0.46 \pm 1.06$  (data not shown). Average weekly hours of screen time ranged from 11 to 25.

Spearman correlations of screen time and sleep variables with demographic and anthropometric variables were assessed. Screen time increased with age, and was inversely correlated with female sex ( $r = -0.09$ ,  $p < 0.001$ ). Parents of Black children reported significantly higher weekly screen time than parents of non-Black children ( $r = 0.23$ ,  $p < 0.001$ ), while the opposite trend was observed in Hispanic/Latinos compared to non-Hispanic/Latinos ( $r = -0.21$ ,  $p < 0.001$ ). Parental income was inversely associated with screen time ( $r = -0.07$ ,  $p < 0.001$ ). Age-sex specific height and weight z-score were both weakly associated with screen time. Of the sleep variables, trouble falling asleep was inversely associated with age-sex specific height ( $r = -0.06$ ,  $p = 0.033$ ), and tiredness was associated with Black race ( $r = 0.15$ ,  $p < 0.001$ ), Hispanic/Latino ethnicity ( $r = -0.14$ ,  $p < 0.001$ ), and parental education ( $r = 0.06$ ,  $p = 0.016$ ).

Relationships between screen time and sleep variables with demographics are in Table 2. Amount of screen time is significantly higher in older children (20.10 hours vs. 18.05 for age 4 and above vs. less than 4 years old,  $p = 0.007$ ), boys (20.17 vs. 17.77 for boys vs. girls,  $p < 0.001$ ), Black children (20.13 vs. 14.90, with  $p < 0.001$ ), and lower income children (19.28 vs. 17.24 for income less than 20K vs. income between 20K and 35K,  $p = 0.014$ ). Children from families with high school to some college education had significantly higher screen time than

children from families with lower than high school education or family with college education and above (Table 2). Black children reported higher levels of tiredness (1.26 vs. 1.07 for Black vs. non-Black,  $p = 0.006$ ) than non-Black children.

Adjusting for age, sex, race, parental education, and parental income, screen time was associated with trouble falling asleep ( $\beta$  per standard deviation = 0.075,  $p = 0.003$ ), low quality of sleep ( $\beta = 0.033$ ,  $p = 0.025$ ), and increased tiredness ( $\beta = 0.061$ ,  $p = 0.005$ ). After adjusting for clustering, screen time was associated with trouble falling asleep ( $\beta$  per standard deviation = 0.064,  $p = 0.029$ , R-Square = 0.008) and increased tiredness ( $\beta = 0.065$ ,  $p = 0.008$ , R-Square = 0.039) but not quality (R-Square = 0.007). This is shown in Table 3. No interaction occurred between BMI z-score and screen time, indicating BMI did not modify the relationships between screen time and the sleep variables.

## **Discussion**

We investigated whether parent-reported screen use was associated with reported sleep symptoms in inner city preschoolers using cross-sectional data. After adjustment for age, sex, race, Hispanic/Latino ethnicity, parental education, and parental income and clustering, average weekly screen time was positively associated with tiredness and difficulty falling asleep or staying asleep. Race and ethnicity were significantly associated with screen time and tiredness. Parents of Black children reported their children engaged in more screen use and were more tired

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during the day compared to parents of non-Black children. The opposite effect was observed in Hispanic/Latino children (part of ‘Non-Black’ category in Table 2); they were more likely to report lower screen use and less tiredness compared to parents of non-Hispanic/Latino children. Parental income was inversely associated with screen time but parental education was not.

Study results support previous literature on associations between screen time and sleep indicators for children. Prior research indicates that children who consume more screen media experience more sleep problems (Brockman et al., 2015; Cespedes et al., 2014; Garrison & Christakis, 2012; Magee et al., 2014; Hale & Guan, 2015; Marinelli et al., 2014; McDonald et al., 2014; Paavonen et al., 2016; Thompson & Christakis, 2005). Our study contributes to this body of research by focusing on low-income preschoolers in an inner-city area of the Midwest. Few have focused on 3-5 year-olds, specifically, and even fewer have focused on 3-5 year-olds in inner-city preschool settings with predominantly Black/African American and Hispanic/Latino children (Caldwell & Redeker, 2015; Sheares et al., 2013; Wilson et al., 2014).

Existing cross-sectional and longitudinal research corroborates that screen time profoundly impacts child health (Anderson et al., 2017; Domingues-Montanari, 2017; Garmy et al., 2017; Gentile et al., 2014; Hoge, Bickham, & Cantor, 2017; Jackson & Cunningham, 2017; Nightingale et al., 2017; Swindle et al., 2017; Verlinden et al., 2012;), including obesity (Garmy et al., 2017; Jackson & Cunningham, 2017; Nightingale et al., 2017) and aggressive behaviors (Anderson et al., 2017; Gentile et al., 2014; Verlinden et al., 2012). Poor child health status is an independent risk factor for lower academic achievement among poor children (Flores et al.,

1999; Spornak et al., 2006). These results warrant further research because they show that populations known to be at risk for adverse health and social outcomes are experiencing negative health factors that could further disadvantage their overall health and academic success. Moreover, these outcomes may be exacerbated due to the association of sleep dysfunction with poor child health and cognitive outcomes that are important for development and school readiness (Quach et al., 2009). The potential compounding impact of poor sleep indicators and health disparities in low-income families requires more research to develop interventions for this population. Early education institutions, especially those for low-income children, are an excellent setting for such interventions.

### **Study Limitations**

An assumption made during this study is that screen time use precedes negative sleep symptoms, not that sleep symptoms precede screen time use. This assumption is based on existing research that suggests the relationship of screen time to sleep symptoms is causal in nature (Garrison & Christakis, 2012). The reverse causality should be considered an alternative hypothesis to be tested through longitudinal studies. This study's results demonstrate an association between screen time and sleep symptoms but fail to show causation due to being cross-sectional in nature. Further research should include other potential stressors that may impose on sleep symptoms of children in low-income families.

## **Considerations for Early Childhood Care and Education**

The Nutrition and Physical Self-Assessment for Child Care (Go NAP SACC) is a federally recognized, evidence-based program that sets best practices for child care programs to shape healthy eating and physical activity habits for young children. The Go NAP SACC best practice for weekly amount of screen time for children 2 years or older is less than 30 minutes in the child care setting or none at all, operating under the assumption that children are receiving additional screen time in their home environments on a daily or weekly basis (Ward et al., 2014). Future research should identify any screen time guidelines or policies in place at preschools as well as if and how those policies are communicated to families. Organizations that have Head Start and GSRP programs are required to match federal funds by 25%. This matching is met through in-kind contributions from parents/guardians and other community institutions. Parent/guardian in-kind contributions most often include attending parent meetings and parent education sessions at education centers as well as school-related activities in the home. These are perfect opportunities to implement screen time reduction interventions and education that consider both the learning and home environments. Future research must also define what the AAP considers to be ‘high quality programming’ as it relates to screen media, and take into consideration the amount of daily screen time that is deemed ‘educational’ and/or ‘high quality’ both in the classroom and the home (including tablets to read stories, Smart Boards for interactive instruction, whether certain television programs are deemed ‘educational’, etc.).

## **Conclusion**

In our study, age, sex, race, parental education, and parental income were all associated with amount of screen time consumed, and race was related to child's level of tiredness. After adjusting for clustering, our study showed screen time consumption was associated with children's ability to fall asleep and how tired they were during the day, as reported by parents.

The preschool children in this study were residents of Metro Detroit, were predominantly Black and Hispanic/Latino, from parents who had a high school to some college education, and from households with incomes of less than \$20,000. Therefore these findings are generalizable to predominantly Black and Hispanic/Latino inner-city preschoolers. Further research is needed to determine the relationship of screen time to sleep symptoms for populations with larger proportions of other races and ethnicities and should explore the association between screen time use and race in more depth. Research in this topic should also incorporate entertainment technology such as cell phone and tablet games as well as what constitutes "high quality" and or "educational" screen time. Our data shows that Hispanic/Latino children experience significantly less screen time and tiredness, and less trouble falling asleep and better quality of sleep (at non-significant levels) than non-Hispanic/Latinos. Further research should examine the cultural norms and parenting strategies used in this population that may inform future interventions.

## **Key Messages:**

- Screen time was associated with trouble falling asleep and increased tiredness when adjusted for potential confounders, and when further adjusted for clustering.
- ‘Educational’ screen time and ‘high quality’ screen time programming that takes place in early learning settings need to be defined in practice.
- Future research should examine screen time policies and guidelines at early childhood education centers as best practices from the literature and resulting from this study indicate that exceeding screen time recommendations for young children can be injurious to their health.
- Future research should examine early childhood education institutions as potential settings for screen time reduction interventions that consider screen time in both the learning and home environments.

Data available upon request from the authors.

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