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Associations among physical activity, screen time, and sleep in low socioeconomic status urban girls☆

Cory J. Greever [a,b], Matthew Ahmadi [b], John Sirard [b], Sofiya Alhassan [b,*]

[a] California Polytechnic State University, Department of Kinesiology, San Luis Obispo, CA, United States
[b] University of Massachusetts, Amherst, Department of Kinesiology, Amherst, MA, United States

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ABSTRACT

Insufficient sleep is associated with higher risk of poor health outcomes in low socioeconomic status (SES) urban elementary age girls. Decreased physical activity (PA) and increased screen time may be associated with poor sleep. This study examined if PA and screen time are associated with sleep in girls from a low SES urban community. Baseline data from 7 to 12 year-old girls (n = 55) from two interventions conducted in Springfield, MA between 2012 and 2015 were used. PA was measured via accelerometry for seven days. Screen time and sleep were assessed via validated questionnaires. Sleep was also assessed via accelerometry in a subsample of girls (n = 24) for 7 days. Associations among PA, screen time, and sleep were analyzed using multiple linear regression. More minutes of screen time per day ($p = 0.01$, $r^2 = 0.35$, r^2 adjusted $= 0.23$) was associated with worse sleep quality ($\beta = 0.50$, $p = 0.02$). There were negative correlations between PA and the number of awakenings per night ($r = -0.45$, $p = 0.04$) and between counts per minute and sleep fragmentation ($r = -0.65$, $p = 0.002$) assessed by accelerometer. In this population, increased screen time was associated with worse sleep quality and decreased PA was correlated with more awakenings per night and higher sleep fragmentation. These findings suggest that screen time and PA may be modifiable risk factors for interventions seeking to improve sleep in this population.

1. Introduction

Children's sleep duration (SD) and sleep quality (SQ) decline significantly as they progress from childhood into adolescence (National Sleep Foundation, 2004; Williams et al., 2013). These trends present a major public health concern, given that insufficient SD and poor SQ have been associated with an increased risk of poor physical (i.e., obesity and diabetes mellitus) and mental (i.e., cognitive function and depression) health throughout the lifespan (Cappuccio et al., 2008; O'Brien, 2009; Hjorth et al., 2014). In order to combat these trends, it is paramount to identify modifiable risk factors that are associated with SD and SQ, especially in populations at high-risk for compromised SD and SQ (Blunden et al., 2012). While SD and SQ decline in all children as they age, children living in low socioeconomic status (SES) urban communities experience a greater reduction in both SD and SQ compared to children living in more affluent communities (Sheares et al., 2013; Crosby et al., 2005; Wong et al., 2013). Several studies have indicated that increased screen time and decreased physical activity (PA) are modifiable risk factors associated with poor sleep in children (Calamaro et al., 2012; Laurson et al., n.d.; Ortega et al., 2011; Ekstedt et al., 2013). It has been suggested that children who are more physically active will be more fatigued at the end of the day, leading to improved sleep (Patel et al., 2012). With respect to screen time, research has shown that increased exposure to light emissions from media devices such as television, cell phones and tablets, especially in the evenings, delays the onset of sleep by attenuating the release of melatonin, a key hormone in initiating the sleep cycle (Chellappa et al., 2011).

Previous studies have examined the relationship between PA, screen time, and SD in children but the findings are inconsistent (Hjorth et al., 2014; Laurson et al., n.d.; Ortega et al., 2011). Furthermore, it remains unclear if decreased PA and/or increased screen time are predictive of compromised SD and SQ in elementary age children living in urban communities. Currently, no studies have examined whether PA and screen time are associated with SD and SQ in elementary age girls living in low SES urban communities (Wong et al., 2013). Therefore, the purpose of this study was to examine associations among PA, screen time,

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* Corresponding author at: University of Massachusetts, Department of Kinesiology, 110 Totman Building, 30 Eastman Lane, Amherst, MA 01003-9258, United States.
E-mail address: alhassan@kin.umass.edu (S. Alhassan).

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SD and SQ in a group of elementary age girls in a low SES urban community.

2. Methods

2.1. Participants

This study was a secondary analysis of baseline data collected from the Mothers and Daughters Dancing Together Trial (MAGNET) and the Girls Dancing and Sleeping for Health (Girls DASH) programs. The MAGNET program was a 12-week after school PA intervention aimed at improving PA levels in urban low SES African-American girls. The Girls DASH program was an 8-week after school PA and sleep education intervention aimed at improving PA and sleep levels in urban low SES girls. Girls were eligible for the MAGNET program if their primary maternal figure identified them as African-American or Black, were between the ages of 7–10 years old and able to participate in physical education at school. Girls were eligible for the Girls DASH program if they were between the ages of 7–12 years old and able to participate in physical education at school. Girls were excluded from both studies if they had any conditions limiting their ability to participate in the PA program or unable to read or understand the assent document in English. Parents and girls provided informed consent and assent, respectively, to participate in this study. The university institutional review board approved the study.

2.2. Physical activity assessment

Trained research staff members collected all data either in the participant's home or at the intervention site. Girls' PA was objectively measured using Actigraph GT3X accelerometers (Actigraph, LLC, Pensacola, FL). Monitors were set to record data in 60-second epochs during the MAGNET study. However, for Girls DASH, we opted to collect data at 15-second epochs. Therefore, all Girls DASH files were converted to 60-second epochs, so that we could employ the same data processing techniques to all accelerometer data. For both studies, girls were instructed to wear the Actigraph on a small elastic belt over their right hip for seven consecutive days excluding times when the monitor would get wet and during nighttime sleep. All data were processed using Actilife 6 software (Actigraph, LLC, Pensacola, FL). Non-wear time was identified and removed from analysis using the Choi et al. (2012) algorithm. In order to be included in the analysis, participants had to wear the monitor for at least 8 h per day and at least three days per week. The Evenson et al. (2008) cut points for children were used to categorize accelerometer counts into periods of sedentary, light PA (LPA), moderate PA (MPA) and moderate-to-vigorous PA (MVPA). Vector magnitude counts per minute (CPM) were assessed as a measure of average movement intensity without relying on categorization into activity intensity categories (Bassett and Wolff-hughes, 2014).

2.3. Child-reported screen time

Child-reported screen time was assessed using a previously validated questionnaire, which has demonstrated high reliability ($r = 0.94$) in elementary age girls living in a low SES urban community (Robinson et al., 2010). Children were asked to report the number of minutes they spent in various types of screen time (e.g. television, movies, computer/tablet) in the morning, afternoon and night on the most recent weekday and weekend day. These values were extrapolated to reflect a weekly value and divided by seven to determine minutes of screen time per day.

2.4. Parent-reported sleep duration and quality assessment

All girls average SD and SQ were assessed via parental report using the Children's Sleep Habits Questionnaire (Owens et al., 2000). This questionnaire has demonstrated high sensitivity ($r = 0.80$), specificity ($r = 0.72$) and test-retest reliability ($r = 0.79$) in identifying sleep problems in elementary age children (Owens et al., 2000). Briefly, this questionnaire is a 45-item questionnaire that asks parents to report the frequency of various sleep behaviors within several domains within a typical week as well as average nightly bed times, morning wake times and SD. The questionnaire items were then aggregated to obtain a composite SQ score (Owens et al., 2000), with a higher score indicating more frequently reported problems and worsened sleep.

2.5. Accelerometer-derived sleep duration and quality

Girls who participated in the Girls DASH program (n = 24) were asked to also wear a triaxial Actigraph accelerometer (Actigraph GT3x/GT3x+/ActisleepBT; Actigraph, LLC, Pensacola, FL) on their non-dominant wrist for seven consecutive days including during nighttime sleep to obtain accelerometer-derived measures of SD and SQ. Recently, the manufacturer ceased producing the Actisleep models and provided firmware and software updates which allowed all of triaxial monitors to measure sleep. Girls were instructed to only remove the wrist monitors during times when they would be completely submerged in water (i.e., swimming). All data were processed using Actilife 6 software (Actigraph, LLC, Pensacola, FL). The same accelerometer compliance procedures were used as previously stated in the physical activity assessment section. Raw acceleration data were collected at 30 Hz and reduced to 60-s epochs for the assessment of nocturnal sleep using the Sadeh et al. (1994) algorithm. This algorithm provided accelerometer-derived measures of bedtimes, wake times, number of minutes spent in bed, number of minutes spent asleep, sleep efficiency (percentage of time spent in bed spent sleeping), number and length of nighttime awakenings and sleep fragmentation index scores. The sleep fragmentation index is a multiplicative measure taking into account both the amount of movement and frequency of awakening during the night after the onset of sleep.

2.6. Physical measures

Girls' height was measured to the nearest 0.1 cm using a portable stadiometer. Girls' weight was measured to the nearest 0.1 kg using a Scale-Tronix 5125 digital scale (Scale-Tronix, LLC, White Plains, NY). BMI was calculated as kg/m^2 and BMI percentile ranks for age and gender were determined using the Center for Disease Control growth charts (Ogden et al., 2002).

2.7. Statistical analyses

Only girls with baseline PA, child-reported screen time, parent-reported SD, and parent-reported SQ data were included in the primary analysis. The PA data failed to meet the assumptions of normal distribution; therefore, a log transformation was applied. Multiple linear regressions were used to determine if PA (percent of time spent in sedentary, LPA, MVPA, and CPM) and child-reported screen time (min per day) explained significant portions of the variance in parent-reported SD and parent-reported SQ. Given that there is a known effect of obesity on sleep in children, BMI percentile was included in all regression models (Van Cauter and Knutson, 2008). In cases where PA and child-reported screen time explained significant portions of the variance in parent-reported SD and SQ, standardized regression coefficients were examined to determine which PA and/or child-reported SB variables were predictive of parent-reported SD and SQ. Given that we only had wrist and hip accelerometer data on the Girls DASH participants (n = 24), partial correlations were chosen rather than multiple linear