Why won't she sleep? Screen exposure and sleep patterns in young infants

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Abstract

The American Academy of Pediatrics recommends infants' exposure to electronic screen-based media be minimized; however, more research is needed to understand effects of viewing screen-based media. Here, we examine relations between media use and sleep. Data were collected from mothers when their infants (N = 429) were four months of age. Mothers answered questions about the time their infants spent watching electronic screen-based media. Exposure to electronic screen-based media was negatively associated with nighttime sleep (but not daytime sleep), such that an hour of screen time was associated with nearly 13 minutes less sleep on a typical night.

Introduction

Infants spend the majority of their first six months of life in sleep. Newborns sleep about 16 hours per each 24-hour cycle, which decreases to 14-15 hours by three months, and to 13-14 hours by six months (De Weerd & Van den Bossche, 2003). Correlational studies have suggested sleep duration is positively associated with the development of an easy temperament and cognitive skills in preschool aged children and older children (Bernier, Beauchamp, Bouvette-Turcot, Carlson, & Carrier, 2013), and too little sleep is associated with negative outcomes including increased risk of obesity in older children (Ednick et al., 2009; Taveras, Rifas-Shiman, Oken, Gunderson, & Gillman, 2008). Importantly, not much is known about longitudinal effects of lost sleep in early infancy (see Ednick et al., 2009 for a review).

A number of characteristics is likely associated with infant sleep duration, including maternal characteristics (e.g., mental health, household income, and marital status; Nevarez, Rifas-Shiman, Kleinman, Gillman, & Taveras, 2010), child characteristics (e.g., health, temperament, genetics, and sex; Blair et al., 2012; Nevarez et al., 2010), and environmental characteristics (e.g., urbanicity, population density, exposure to light, and screen time; Bottino et al., 2012; Harrison, 2004).

The American Academy of Pediatrics has recommended parents of children under 18 months should avoid allowing excessive exposure to electronic screen-based media (Chassiakos, Radesky, Christakis, Moreno, & Cross, 2016). This is supported by even more strict recent recommendations by World Health Organization (WHO), which has stated infants under a year old should not have screen time, and four-month-old infants should have 12-16 hours of good quality sleep in every 24-hour period (WHO, 2019). A systematic literature review of 67 correlational studies has shown that exposure to screen-based media in school-aged children and

adolescents is negatively associated with duration and quality of sleep (Hale & Guan, 2015). However, the nature of this relationship is likely to be different in very young infants who likely do not yet comprehend information presented through screen-based media (Hipp et al., 2017). Those studies that have investigated the role of electronic screen-based media use and sleep in infancy have primarily focused on six-month-old and older infants (Cespedes et al., 2014; Schmidt, Rich, Rifas-Shiman, Oken, & Taveras, 2009), or have looked at children of all ages together (Przybylski, In Press). The present study leverages a large, international dataset to investigate whether electronic screen-based media use is associated with sleep detriments in children under six months of age.

Methods

Participants were recruited as a part of a larger longitudinal study of parents and their first-born children (The New Fathers and Mothers Study) in the United States (US), United Kingdom (UK), and the Netherlands (NL). To be eligible for the current study, potential participants had to: (1) be first-time parents, (2) be living together at the time of their child's birth, (3) be expecting delivery of a healthy singleton baby, and (4) be planning to speak the native language of the recruiting country (i.e., English or Dutch) as the primary language with their child. We recruited 446 expectant mothers attending prenatal classes and appointments at local hospitals in the East of England and in New York City, and at maternity events—state-sponsored informational events about pregnancy, delivery, and care in the pre- and post-natal periods—in the Netherlands. An additional 10 families were recruited but these families were not eligible for follow-up when the infants were four months old due to birth complications or having left the area. All remaining participants were born full term (after 36 weeks) and without birth complications. Of families recruited, 429 (99.54%; ($N_{England}$ = 188; N_{NYC} =116; $N_{Netherlands}$ =

116) families agreed to participate in a home visit when their infants (218 boys, 211 girls) were 4 months old, M_{Age} = 4.25 months, *SD* = 0.46 months, range: 2.97 – 6.23 months. Both mothers and fathers had high levels of educational attainment: 84.1% of mothers and 76.1% of fathers had a bachelor's degree or higher. Parents completed comprehensive questionnaires either during the home visit or before the home visit via an online portal. Data for the current study were taken from these questionnaires.

Screen Time. Parents (mostly mothers) were asked to report the amount of time infants were exposed to screens on a regular basis. Parents reported "Number of hours watching TV/DVDs or looking at iPADs or computer" on a typical weekday, weekend day, and on the day prior to completion of the questionnaire. Screen time on a typical weekday, weekend day, and the day prior to survey completion were highly correlated (all *r*s > .64; *p*s < .001). A single variable representing average screen time on a given day was computed by dividing the average screen time per week by seven [(5*weekday + 2*weekend) / 7]. The computed variable was very strongly correlated with both weekdays (*r* = .98) and weekend days (*r* = .82). This item captures a global measure of screen time, has been used in previous investigations of the effects of television exposure, and demonstrates acceptable reliability and validity (LeBlanc et al., 2015; Salmon, Campbell, & Crawford, 2006; Sigmundová, Sigmund, Vokáčová, Trhlíková, & Bucksch, 2016).

Child Sleep. Parents (mostly mothers) completed the Brief Infant Sleep Questionnaire (BISQ), which has previously been shown to be a valid, psychometrically sound measure of infant sleep (Sadeh, 2004; Spruyt et al., 2008). Mothers reported the amount of time infants spent in sleep during an average night (7pm to 7am) and during an average day (7am to 7pm). Mothers' answers to these two questions from the BISQ determined sleep duration. In addition,

mothers reported the average number of times their infant wakes during the night, and the degree to which they consider their infants' sleep to be a problem. The sleep problem question was a three-point scale whose options were "a serious problem," (N = 11) "a small problem," (N = 120) and "not a problem" (N = 290). Dummy variables were included in analyses with "not a problem" as the reference group. Retrospective questions were asked so that parents' overall attitudes about their infants' sleep could be assessed, and to reduce demands on families.

Covariates. A host of control variables, outlined below, were included in regression analyses for child, maternal, and family characteristics. In addition to the continuous covariates below, variables were also included to represent country with the US as the reference group, whether the child was receiving breastmilk at time of questionnaire completion, whether the child was regularly attending any form of non-familial child care, whether the child regularly slept in the parents' bed or in a co-sleeper (i.e., anything that attaches to the edge of the parents' bed with at least one open side such that there is no separation between the parent bed and child bed), and whether mothers were working full- or part-time.

Maternal Sleep Duration. Mothers completed a subset of items from the Pittsburgh Sleep Quality Index (PSQI) (Buysse, Reynolds III, Monk, Berman, & Kupfer, 1989). Responses to a single item which asked mothers to report their average hours of sleep per night ["During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)"] were used as the maternal sleep variable.

General Well-being. Mothers completed the General Health Questionnaire (GHQ) in which higher values indicate more concerns with general well-being (Goldberg et al., 1997). Questionnaire items showed adequate internal consistency in the present population (α = .78).

Depression. Mothers completed the Center for Epidemiological Study Depression scale (CES-D) in which higher values indicate higher levels of depression symptomatology (Radloff, 1977). Items showed adequate internal consistency ($\alpha = .85$).

Anxiety. Mothers completed the State Trait Anxiety Inventory; higher values indicate higher levels of anxiety symptomatology (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Items showed adequate internal consistency ($\alpha = .78$).

Family Income. Mothers reported annual household income in their respective country's currency. Annual household income was divided by the median or mean income for the smallest granular area available for the year in which income was reported (2015). That is, for the US sample, a proportion of the New York state median income (60,850 dollars) was computed. For the UK, a proportion of the country median income (26,129 pounds) was computed. For the Netherlands, a proportion of the mean country income (35,000 euros) was computed.

Child Temperament. Mothers completed the Infant Behavior Questionnaire-Very Short Form (IBQ) (Putnam, Helbig, Garstein, Rothbart, & Leerkes, 2014). This 36-item measure has been widely used to characterize infant temperament, which is represented by three scale scores: Negative Affect (IBQ-NA), Effortful Control (IBQ-EC), and Fearfulness (IBQ-F). Two of the three scales did not demonstrate high levels of internal consistency ($\alpha_{IBQ\text{-}NA} = .52$; $\alpha_{IBQ\text{-}EC} = .49$; $\alpha_{IBQ\text{-}F} = .77$) but were used as recommended by publishers for consistency with prior literature.

All analyses were carried out in *Mplus 8* (Muthen & Muthen, 2017). Missing data was accounted for using Full Information Maximum Likelihood estimation.

Results

Descriptive statistics are shown in Tables 1 and 2, and Table 3 shows bivariate correlations among all variables included in the model. On average, infants in the sample slept

13 hours per 24-hour day (M = 13.00, SD = 2.18), and spent nearly one hour per day engaged with electronic screen-based media (M = 0.85, SD = 1.23). However, one-way ANOVAs revealed significant differences in sleep and screen time by country, [$F(2, 404) = 30.96$, $p < .001$; $F(2, 392) = 4.82$, $p = .009$, respectively]. Bonferroni post-hoc tests revealed significant differences across all countries for sleep. Mothers of infants in the Netherlands (M_{NL} = 14.11 hours, SD = 2.40) reported their children slept more than did mothers of infants in the UK (M_{UK} = 12.25 hours, SD = 2.00) and the US (M_{US} = 13.18, SD = 1.58). Infants in the US also slept more than did infants in the UK. However, further analysis revealed the country differences in sleep time was attributable to daytime rather than nighttime sleep [$F(2, 406) = 50.80$, $p < .001$; $F(2, 407) = 0.98$, $p = .377$, respectively], such that infants in the Netherlands slept more during the day than did infants in either of the other two countries, and infants in the US slept more during the day than did those in the UK (M_{NL} = 4.40 hours, SD = 1.72; M_{UK} = 2.77 hours, SD = 1.24; M_{US} = 3.62, SD = 1.21).

UK mothers reported greater amounts of screen time than did US mothers (M_{UK} = 1.05, SD = 1.39; M_{US} = 0.63, SD = 0.97); there were no differences between reported screen time in the Netherlands and either the US or UK.

A series of bivariate correlations is also noteworthy. The three indicators of maternal mental health symptomatology were all strongly correlated with one another (rs = .49 – .61, ps < .001) and all three mental health symptomatology indicators were weakly associated with maternal sleep (rs = -.13 – -.23, ps < .05) such that mothers who reported higher levels of mental health symptomatology also reported that they got less sleep on a regular night. Finally, while maternal sleep was associated with both infant daytime and nighttime sleep, it was nearly three

times more strongly associated with nighttime than daytime sleep (r = .31, p < .001; r = .11, p = .026, respectively).

To investigate whether increased screen time was associated with decreased sleep duration in young infants, we conducted a linear regression in which sleep duration in a typical 24-hour cycle was regressed on screen time and covariates. Results are shown in Table 3. The association between screen exposure and total sleep duration after controlling for covariates are shown graphically by country in Figure 1. Increased screen time was associated with decreased sleep, b = -0.18, p = .027, 95% CI[-0.34,-0.02]. In addition, residing in the UK was associated with less sleep than residing in the US (b = -1.02, p = .010, 95% CI[-2.03,-0.47]). Further analyses indicated that the association between screen time and sleep was specific to nighttime sleep duration (Figure 2; b = -0.21, p = .001, 95% CI[-.32,-0.09]), and that there was no association between screen time and daytime sleep (b = 0.03, p = .610, 95% CI[-0.09,0.14]). Interactions between country and screen time were not significant for any of the outcome measures (ps > .10), suggesting no cross-country differences in the association between screen time and sleep.

Discussion

In this sample, sleep duration and electronic screen-based media exposure are inversely related, even with potential confounds taken into consideration. Further, the magnitude of this relation might be clinically meaningful: For each hour of electronic screen-based media to which an infant is exposed, she is sleeping, on average, 13 minutes less per night. That is, a child who spends an hour per day viewing electronic screen-based media for a given week may be sleeping nearly an hour and a half less during that week.

This is consistent with findings in adults (Exelmans & Van den Bulck, 2017), older children (Brambilla et al., 2017; Brockmann et al., 2015; Marinelli et al., 2014), and adolescents (Falbe et al., 2015), which have consistently demonstrated a negative relation between use of electronic screen-based media and sleep. Studies with older children and adults have suggested screen exposure before bedtime may be detrimental for older children and adults (Czeisler & Shanahan, 2016; Green, Cohen-Zion, Haim, & Dagan, 2017), but, as young infants spend over half of the 24-hour cycle asleep, any media at all may affect sleep duration, which, in turn, might negatively impact development.

Despite country differences, the average child within the present sample slept well within recommended limits (Paruthi et al., 2016). Media was negatively related to sleep regardless of country of participation. However, the association between country and sleep was present only for aggregated and daytime sleep, which is consistent with prior research that showed infants in the US napped more and for longer than infants in the UK (Mindell, Sadeh, Wiegand, How, & Goh, 2010). The country differences here were striking, suggesting that culture, geography, or an interaction between the two have affected a biological process. Especially when considering screen exposure within these different cultures, care should be taken to encourage parents to consider all of the things that might contribute to less sleep in their infants.

The ubiquitous nature of the relation between screen time and sleep duration supports the theory that there are underlying biological processes occurring. Chang, Aeschbach, Duffy, and Czeisler (2015) found that using a light-emitting device before bed decreased EEG delta/theta activity and suppressed rising melatonin secretion, which is necessary for sleep. They also found a delay in the circadian pacemaker responsible for daily rhythms of melatonin secretion as a result of exposure to electronic screens, which could affect sleep on subsequent days (Chang et

al., 2015). Melatonin concentration and sleep circadian rhythms both become active in the first few months of life (McGraw, Hoffmann, Harker, & Herman, 1999), and sleep-wake rhythms mature over time, gradually decreasing sleep fragmentation (Bathory & Tompoulos, 2017). Altering the formation of these rhythms with screens could have adverse effects. In addition, maternal sleep was strongly associated with infant sleep. There may be further biological underpinning to this relationship, or there may be household trends that lead a child to sleep less often. Indeed, mothers who use screen time whilst feeding at night may be biologically affecting their own sleep and their children's by introducing sleep deprecating light exposure. This association, as well as other important predictors such as whether or not parents think their infants' sleep is a major problem, are important to consider in the narrative. However, though these did predict less sleep, media exposure was significantly related to sleep over and above these ecological factors.

Limitations and Conclusions

There are several limitations that must be noted for the interpretation of these findings. First, neither causality nor directionality can be inferred: These data are derived from a single time point of a broader study, and it is possible that there are characteristics of child sleep that make parents more likely to expose some children to electronic screen-based media than others beyond those parent and child characteristics included in this study. In addition, maternal report of infant sleep and media use is likely more biased than direct observation and physiological measurement and might discount fathers' use of media with their children when mothers are not around. Further, our data do not allow for us to investigate the effect of timing, content, or device, or the reason families are choosing to use electronic screen-based media, which might moderate the effects of screen time on sleep (Przybylski, In Press), nor can we investigate when

and whether mothers where using screens (e.g., when children are sleeping). Finally, our sample is relatively highly-educated, affluent, and all families are intact, suggesting generalizing these findings may not be possible for all groups of people, especially for those in demographics who may be exposed to higher rates of screen use.

Though cross-sectional, our findings support American Academy of Pediatrics and WHO recommendations that parents should avoid screen-based media exposure for children under 18 months of age, and particularly for young infants. Beyond potential detrimental effects of screen time on cognitive skills, the present findings suggest potentially detrimental longitudinal effects on infant sleep duration, which may have cascading effects for development throughout early childhood, though whether this is true remains to be investigated. Further study is needed to better understand the longitudinal associations of sleep, as well as cognitive and health outcomes, with infant electronic screen-based media use.

References

Bathory, E., & Tompoulos, S. (2017). Sleep regulation, physiology and development, sleep duration and patterns, and sleep hygiene in infants, toddlers, and preschool-age children. *Current Problems in Pediatric and Adolescent Health Care, 47*(2), 29-42. doi:10.1016/j.cppeds.2016.12.001

Bernier, A., Beauchamp, M., Bouvette-Turcot, A., Carlson, S., & Carrier, J. (2013). Sleep and cognition in preschool years: Specific links to executive functioning. *Child Development, 84*(5), 1542-1553. doi:10.1111/cdev.12063

Bottino, C., Rifas-Shiman, S., Kleinman, K., Oken, E., Redline, S., Gold, D., . . . Taveras, E. (2012). The association of urbanicity with infant sleep duration. *Health and Place, 18*(5), 1000-1005. doi:10.1016/j.healthplace.2012.06.007

Brambilla, P., Giussani, M., Pasinato, A., Venturelli, L., Privitera, F., del Giudice, E., . . . Group, C. p. s. S. (2017). Sleep habits and pattern in 1-14 years old children and relationship with video devices use and evening and night child activities. *Italian Journal of Pediatrics, 43*(7). doi:10.1186/s13052-016-0324-x

Brockmann, P. E., Diaz, B., Damiani, F., Villarroel, L., Nunez, F., & Bruni, O. (2015). Impact of television on the quality of sleep in preschool children. *Sleep Medicine, 20*, 140-144. doi:10.1016/j.sleep.2015.06.005

Buysse, D., Reynolds III, C., Monk, T., Berman, S., & Kupfer, D. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research, 28*(2), 193-213. doi:10.1016/0165-1781(89)90047-4

Cespedes, E., Gillman, M., Kleinman, K., Rifas-Shiman, S., Redline, S., & Taveras, E. (2014). Television viewing, bedroom television, and sleep duration from infancy to mid-childhood. *Pediatrics, 133*(5), e1163-e1171. doi:10.1542/peds.2013-3998

Chang, A.-M., Aeschbach, D., Duffy, J., & Czeisler, C. (2015). Evening use of light-emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness. *Proceedings of the National Academy of Sciences of the United States of America, 112*(4), 1232-1237. doi:10.1073/pnas.1418490112

Czeisler, C., & Shanahan, T. (2016). Problems associated with use of mobile devices in the sleep environment- Streaming instead of dreaming. *JAMA Pediatrics, 170*(12), 1146-1147. doi:10.1001/jamapediatrics.2016.2986

De Weerd, A., & Van den Bossche, R. (2003). The development of sleep during the first months of life. *Sleep Medicine Reviews, 7*(2), 179-191. doi:10.1053/smrv.2002.0198

Ednick, M., Cohen, A., McPhail, G., Beebe, D., Simakajornboon, N., & Amin, R. (2009). A review of the effects of sleep during the first year of life on cognitive, psychomotor, and temperament development. *Sleep, 32*(11), 1449-1458. doi:10.1093/sleep/32.11.1449

Exelmans, L., & Van den Bulck, J. (2017). Bedtime, shuteye time and electronic media: sleep displacement is a two-step process. *Journal of Sleep Research, 26*, 364-370. doi:10.1111/jsr.12510

Falbe, J., Davison, K., Franckle, R., Ganter, C., Gortmaker, S., Smith, L., . . . Taveras, E. (2015). Sleep duration, restfulness, and screens in the sleep environment. *Pediatrics, 135*(2), e367-e375. doi:10.1542/peds.2014-2306

Goldberg, D., Gater, R., Sartorius, N., Ustun, T., Piccinelli, M., Gureje, O., & Rutter, C. (1997). The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychological Medicine, 27*(1), 191-197. doi:10.1017/S0033291796004242

Green, A., Cohen-Zion, M., Haim, A., & Dagan, Y. (2017). Evening light exposure to computer screens disrupts human sleep, biological rhythms, and attention abilitiees. *Chronobiology International, 34*(7), 855-865. doi:10.1080/07420528.2017.1324878

Hale, L., & Guan, S. (2015). Screen time and sleep among school-aged children and adolescents: A systematic literature review. *Sleep Medicine Reviews, 21*, 50-58. doi:10.1016/j.smrv.2014.07.007

Harrison, Y. (2004). The relationship between daytime exposure to light and night-time sleep in 6-12-week-old infants. *Journal of Sleep Research, 13*(4), 345-352. doi:10.1111/j.1365-2869.2004.00435.x

Hipp, D., Gerhardstein, P., Zimmermann, L., Moser, A., Taylor, G., & Barr, R. (2017). The dimensional divide: Learning from TV and touchscreens during early childhood. In R. Barr & D. N. Linebarger (Eds.), *Media Exposure During Infancy and Early Childhood* (pp. 33-54). Switzerland: Springer International Publishing.

LeBlanc, A. G., Broyles, S. T., Chaput, J. P., Leduc, G., Boyer, C., Borghese, M. M., & Tremblay, M. S. (2015). Correlates of objectively measured sedentary time and self-reported screen time in Canadian children. *International Journal of Behavioral Nutrition and Physical Activity, 12*(1), 38.

Marinelli, M., Sunyer, J., Alvarez-Pedrerol, M., Iniguez, C., Torrent, M., Vioque, J., . . . Julvez, J. (2014). Hours of television viewing and sleep duration in children a multicenter birth cohort study. *JAMA Pediatrics, 168*(5), 458-464. doi:10.1001/jamapediatrics.2013.3861

McGraw, K., Hoffmann, R., Harker, C., & Herman, J. (1999). The development of circadian rhythms in a human infant. *Sleep, 22*(3), 303-310. doi:10.1093/sleep/22.3.303

Mindell, J., Sadeh, A., Wiegand, B., How, T., & Goh, D. (2010). Cross-cultural differences in infant and toddler sleep. *Sleep Medicine, 11*(3), 274-280. doi:10.1016/j.sleep.2009.04.012

Muthen, L., & Muthen, B. (2017). MPLUS 8. Los Angeles, CA: Muthen & Muthen.

Nevarez, M., Rifas-Shiman, S., Kleinman, K., Gillman, M., & Taveras, E. (2010). Associations of early life risk factors with infant sleep duration. *Academic Pediatrics, 10*(3), 187-193. doi:10.1016/j.acap.2010.01.007

Paruthi, S., Brooks, L., D'Ambrosio, C., Hall, W., Kotagal, S., Lloyd, R., . . . Wise, M. (2016). Pediatric sleep duration consensus statement: A step forward. *Journal of Clinical Sleep Medicine, 12*(12), 1705-1706. doi:10.5664/jcsm.6368

Przybylski, A. K. (In Press). Digital Screen Time and Pediatric Sleep: Evidence from a Preregistered Cohort Study. *The Journal of Pediatrics*. doi:10.1016/j.peds.2018.09.054

Putnam, S., Helbig, A., Garstein, M., Rothbart, M., & Leerkes, E. (2014). Development and assessment of short and very short forms of the infant behavior questionnaire-revised. *Journal of Personality Assessment, 96*(4), 445-458. doi:10.1080/00223891.2013.841171

Radloff, L. (1977). The CES-D scale: A self report depression scale for research in the general population. *Applied Psychological Measurements, 1*(3), 385-401. doi:10.1177/014662167700100306

Sadeh, A. (2004). A brief screening questionnaire for infant sleep problems: Validation and findings for an internet sample. *Pediatrics, 113*(6), e570-577.

Salmon, J., Campbell, K. J., & Crawford, D. A. (2006). Television viewing habits associated with obesity risk factors: a survey of Melbourne schoolchildren. *Medical Journal of Australia, 184*(2), 64-67.

Schmidt, M., Rich, M., Rifas-Shiman, S., Oken, E., & Taveras, E. (2009). Television viewing in infancy and child cognition at 3 years of age in a US cohort. *Pediatrics, 123*(3), e370-e375. doi:10.1542/peds.2008-3221

Sigmundová, D., Sigmund, E., Badura, P., Vokáčová, J., Trhlíková, L., & Bucksch, J. (2016). Weekday-weekend patterns of physical activity and screen time in parents and their pre-schoolers. *BMC Public Health, 16*(1), 898.

Spielberger, C., Gorsuch, R., Lushene, R., Vagg, P., & Jacobs, G. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Spruyt, K., Aitken, R., So, K., Charlton, M., Adamson, T., & Horne, R. (2008). Relationship between sleep/wake patterns, temperament and overall development in term infants over the first year of life. *Early Human Development, 84*(5), 289-296. doi:10.1016/j.earlhumdev.2007.07.002

Taveras, E., Rifas-Shiman, S., Oken, E., Gunderson, E., & Gillman, M. (2008). Short sleep duration in infancy and risk of childhood overweight. *Archives of Pediatrics and Adolescent Medicine, 162*(4), 305-311. doi:10.1001/archpedi.162.4.305

Touchette, E., Dionne, G., Forget-Dubois, N., Petit, D., Perusse, D., Falissard, B., . . . Montplaisir, J. (2013). Genetic and environmental influences on daytime and nighttime sleep duration in early childhood. *Pediatrics, 131*(6), e1874-e1880. doi:10.1542/peds.2012-2284

World Health Organization (2019). To grow up healthy, children need to sit less and play more: New WHO guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age.