



Sleep Patterns and Health Status in Homeschool Children

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Abstract

Background: With a growing number of children being educated in the home, it is crucial to better understand how this setting might impact health.

Methods: The aim of this study was to describe sleep patterns as they relate to physical activity, weight status, and cardiovascular health in a group of homeschool children within the United States. 25 participants ages 8-16 were measured by accelerometry during seven consecutive days to determine sleep and physical activity behaviors. Other measures included Body Mass Index, body fat percentage, and aerobic threshold (VO₂).

Results: Significant relationships were found between sleep patterns based on gender, age, and day-to-day activity associations.

Conclusions: It was determined that children who were more physically active slept less at night. Lastly, behaviors were very consistent in this group with little variance between weekday and weekend sleep and physical activity patterns.

Keywords: Accelerometry; Children; Adolescence; Cardiovascular health

Introduction

The number of families choosing to homeschool has steady increased in recent years [1]. Reasons for this increase include educational beliefs; values and morals; well-being and safety; and family unity (avoiding the negative influence that schooling has on family life) [2]. Homeschool children are primarily taught by one of the parents in the home, and can study this way until graduating from the school system. Researchers have compared homeschool children to those in traditional schools to determine what influence this unique environment might have on the child's development. For instance, it has been suggested that homeschool children have similar social traits (self-esteem, friendships, etc...) [3], and perform academically comparable, and in some cases better [4], than public school children. Though these findings suggest little differences between the social and cognitive development of children in the homeschool environment, little is known about their healthy behavior patterns.

Research that looks at children's health factors (i.e. cardiovascular health, physical activity or fitness levels, and sleep patterns) primarily focus on public school children due to the easy access to this population. The political history of homeschooling has constrained the data that can be collected at the state level [5], leading to little knowledge of homeschoolers' healthy behaviors [6]. Literature looking at children's sleep patterns suggests that there might be a link between sleep schedules and indicators of obesity. Cappuccio and colleagues [7] conducted a meta-analysis of 30,000 children worldwide, and found that cross-sectional studies have consistently shown children with short sleep to be at increased risk of obesity. There are however

varying views on whether or not duration is what links sleep to indicators of obesity [8]. Newer research has begun to look at actual sleep patterns (e.g. bedtime, quality of sleep, wake time) as a stronger predictor than total sleep duration. For instance, Olds and colleagues [9] found that late-bed/late-rise adolescents were 1.77 times more likely to have low physical activity levels. Other studies found that morning-type children tend to have a lower BMI than evening-type children [10,11].

The links between sleep patterns and levels of physical activity are still being discussed. The few studies that have explored accelerometer-based measures of physical activity and sleep patterns all found that there were either no significant relationships between minutes of physical activity and sleep duration [12,13]; or that being active during the day actually decreased sleep duration at night [14-16]. Though these studies display a common trend between physical activity and sleep duration, they do not look at the relationship between actual quality of sleep and physical activity levels.

The purpose of this study was to expand on the previous research to determine if physical activity levels were associated to not only sleep duration, but also sleep quality, measured as sleep efficiency. Sleep efficiency was determined by comparing participant's time spent resting and actual time sleeping [17]. Sleep efficiency, or time it takes to fall asleep, is an important factor of healthy sleep, or sleep hygiene [18]. This study also looked to describe the day-to-day sleep patterns within this specific population of children that is currently missing from the literature. It has been established that behavior patterns in public school children are influenced by external factors, such as the need to wake up to attend school [9]. Since the homeschool schedule is determined by each family, and differs from one household to the next, this factor should be explored. There is a complete lack of literature on how the unique schedule of the homeschool environment

might influence behavior patterns. Therefore, this study looks to determine whether sleep duration and sleep efficiency were compared to weight status, physical activity, and sedentary behaviors in a small sample of homeschool children.

Method and Materials

This study examined the relationship between objective measures of sleep efficiency and physical activity, weight status (BMI and body fat %) and cardiovascular health (VO₂) of a group of homeschooling children within the United States. The sample included 25 participants ages 8-16. The demographic composition included a majority of males (53.3%) over females (46.7%) with ages grouped for the purpose of this study as 8-10 (32%), 11-12 (52%), and 13-16 (16%) year olds. This research study was approved by the author's respective Institutional Review Board for the Protection of Human Subjects. Proper consent forms were obtained from all participants; including both the children and their parents.

Sleep efficiency and physical activity levels were objectively measured by asking participants to wear a clinically validated accelerometer device (SenseWear[®] Mini) for seven consecutive days. Sleep efficiency was determined by comparing time in bed and actual time sleeping [19]. Physical activity measures were categorized based on Metabolic Equivalent of Task (MET) levels, or an index of the intensity of activities. For this study, results are recorded as sedentary activity (less than 1.5 METs), and moderate physical activity (3.0-6.0 METs). The devices were worn for a seven day period. Study compliance was high with an average wear time of 22.67 hours (SD=1.88) per day, an impressive overall tracking time of 94.5%.

Body composition was determined by calculating Body Mass Index (BMI) and body fat percentages. Body Mass Index (BMI) was

measured using the subject's height and weight. Standing height was measured using a wall-fixed stadiometer. Body weight was measured using a calibrated scale. All subjects were measured in light-weight clothing containing no metal and without shoes. Body fat percentage was measured using a handheld bioelectrical impedance analysis (BIA), which has been shown to be an accurate method in estimating body fat percentage in children [20].

Aerobic capacity was determined by calculating estimated VO₂ levels using the 20-meter PACER (Progressive Aerobic Cardiovascular Endurance Run). This test uses a formula that compares each participant's running results with their height and weight to estimate their capacity to perform sustained exercise, or estimated VO₂ levels [21].

Multiple analysis procedures were used to answer the research questions presented in this study using SPSS (Statistical Package for the Social Sciences) software. Descriptive statistics were used to explain the data results for the sleep and activity levels. Independent t-tests were used to determine mean differences between gender. A One-Way Analysis of Variance (ANOVA) was used to determine differences between the different age groups. Pearson's correlations were used to determine relationships between the physiological factors and the test variables.

Results

This study identified several trends involving sleep patterns and several of the health variables. Based on multiple factors, relationships were found between sleep duration, sleep efficiency, aerobic capacity, body composition, and minutes of daily physical activity.

Variables	Groups (N)	Weekday Sleep Mean (SE)	Weekend Sleep Mean (SE)	Weekday MPA Mean (SD)	Weekend MPA Mean (SD)	BMI (SD)	BF% (SD)	VO ₂ (SD)
Overall	25	7.4hrs (82.9%)	7hrs (80.3%)	183 min (112)	170 min (111)	17.9 (2.6)	22.5 (8.8)	44.6 (4.2)
Gender	Male (14)	7.25hrs (85%)	6.7hrs (81%)	224 min (118)	192.8 min (117.6)	17.8 (3)	16.7 (6.3)	46.2 (4.6)
	Female (11)	7.5hrs (83%)	7.3hrs (80%)	131 min (81.8)	141 min (100)	18 (2.3)	30 (5.1)	42.5 (2.3)
Age	8-10 (13)	7.4 hrs (81%)	6.8 hrs (76%)	172 min (110)	163 min (110)	17.3 (2.4)	25 (8.9)	43.2 (3.6)
	11-12 (5)	7.6 hrs (87%)	7.3 hrs (93%)	208 min (106)	200 min (88)	17.6 (2.1)	21.2 (8.1)	46.3 (4.3)
	13-16 (7)	7.2 hrs (83%)	7 hrs (84%)	187 min (134)	162 min (137)	19.2 (3.3)	18 (2.7)	45.8 (4.8)

Note: SE represents the Sleep Efficiency, or ratio between rest and actual sleep. SD is the Standard Deviations for each of the reported mean scores. PA is represented by the average Moderate Physical Activity of the participants. BMI represents Body Mass Index. BF% represents the body fat percentage of each participant. VO₂ represents aerobic threshold or an indicator of cardiovascular health.

Table 1: Indicators of Sleep Habits and Health Status of Homeschool Children

Sleep patterns, physical activity levels, and health status

General comparisons revealed interesting relationships between sleep duration and physical activity. It was determined that children who engaged in more physical activity tended to have lower sleep duration. This negative relationship was most significant between levels of moderate physical activity (MPA) and sleep duration ($r=-.49$, $p=.014$). Furthermore, children who engaged in more sedentary behavior logged significantly higher levels of sleep ($r=.71$, $p=.001$). Though overall sleep duration showed significant relationships to activity patterns, no significant results were found between sleep efficiency percentages; suggesting that higher levels of physical activity were not significantly related to better quality of sleep. Table 1 displays the descriptive statistics for the test variables used in this study.

When comparing behavior patterns between the weekday and weekend, and when looking at gender and age, significant correlations were discovered. These relationships are discussed in this section.

Weekday and weekend behavior patterns

The children in this study had very consistent behavior patterns between the weekday and weekend comparisons. Pearson correlations determined significant relationships between their weekday and weekend sleep patterns ($r=.488$, $p=.013$), as well as, significantly strong relationships between weekday and weekend physical activity levels ($r=.757$, $p=.001$).

In regards to the aerobic capacity and weight status, weekday sleep and activity patterns had more significant influence on those variables than weekend patterns. For example, weekday (Monday-Friday) physical activity levels were significantly associated with both body fat percentage ($r=-.578$, $p=.002$), and estimated VO_2 levels ($r=.647$, $p=.001$). Similarly, sedentary behavior patterns during the week were correlated to higher body fat percentages ($r=.41$, $p=.044$).

Behavior patterns, age, and gender

When looking at sleep patterns and physical activity levels of the participants by age and gender, interesting relationships were found. Though not significant, the 11-12 year olds had the highest overall levels of physical activity, sleep duration, estimated VO_2 , and the highest sleep efficiency percentages (Table 1). When running One-way ANOVA tests, and a Post Hoc (Tukey HSD), it was found that the 11-12 age group had significantly higher ($f=3.97$, $p=.034$) sleep efficiency patterns during the weekend when compared to the other two age groups. Furthermore, it was determined that the 11-12 year olds logged an average of 37 more minutes of physical activity per weekend day (Saturday and Sunday).

When looking at gender, similar relationships were found between to physical activity levels, sleep patterns, and indicators of health. Independent t-tests determined that the boys in this study had higher overall levels of physical activity, estimated VO_2 , and higher sleep efficiency percentages. Specifically, the boys were significantly more active during the week, including LPA ($t=2.3$, $p=.029$), MPA ($t=2.2$, $p=.037$), and VPA ($t=2.2$, $p=.038$), when compared to the girls. The boys also had significantly higher estimated VO_2 levels ($t=2.6$, $p=.017$), and significantly lower body fat percentage ($t=5.8$, $p=.001$). Though the boys did average less sleep (34.2 minutes) per night, their sleep efficiency percentage was consistently higher throughout the entire week (Table 1).

Discussion

This exploratory study provides an assessment of the day-to-day behavior patterns of an understudied population of children. Though there are limitations (i.e. small sample size, limited geographic location, etc...) to this study, and cannot be generalized to all homeschooling children, these results provide a preliminary look into a group of children that is missing from the literature. It was determined that gender, age, and weekday-weekend activity levels influenced sleep patterns. Though this type of available health data on homeschooling youth is currently missing from the literature, certain comparisons were found between existing research on public school children.

Homeschool and public school children are often compared due to the drastic environmental differences between the two settings. The most notable difference between the homeschool children in this study and previous research on public school children is the weekday and weekend behavior patterns. This study found significantly little variation between weekday and weekend sleep patterns and physical activity levels amongst the homeschool children. Whereas in public school children consistent variance is often cited in both sleep patterns [22] and physical activity levels [23] between weekday and weekend patterns. Specifically, public school children are typically more active [23,24] and sleep [22] better during the week when compared to the weekend. The implication of this study is that elements of the homeschool environment and schedule might promote consistent sleep levels and physical activity patterns; which is important when trying to establish habitual health behaviors in children.

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