

THE EFFECTS OF PHYSICAL ACTIVITY ON SLEEP PATTERNS IN  
CHILDREN WITH DEVELOPMENTAL DISABILITIES

By

Rebecca Griffith

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Committee Membership

Dr. Jill Pawlowski, Committee Chair

Dr. Chris Hopper, Committee Member

Dr. David Adams, Committee Member

Dr. Taylor Bloedon, Program Graduate Coordinator

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## ABSTRACT

### THE EFFECTS OF PHYSICAL ACTIVITY ON SLEEP PATTERNS IN CHILDREN WITH DEVELOPMENTAL DISABILITIES

Rebecca Griffith

**Problem:** Individuals with developmental disabilities should be engaged in 150 minutes of physical activity every week to experience health benefits including an increase in duration and quality of sleep. Individuals with developmental disabilities who get quality, regular sleep have a lower frequency of challenging behaviors. One way to increase physical activity engagement among individuals with disabilities is to engage their family in physical activity together. **Purpose:** To analyse the effects of engaging in a family centered physical activity program on the duration and quality of sleep in a young adult with Down syndrome. **Method:** The participant engaged in the Humboldt State Fitfam Program which was an eight week family-centered physical activity program consisting of a one week in-person, educational component and seven weeks of independent physical activity where parents reported amount and type of physical activity as well as duration and quality of sleep on a weekly basis. **Results:** Graphical depictions indicate that there was an inverse relationship between MVPA and hours of sleep. **Discussion:** The findings from this case study were similar to findings from other studies that showed a decrease in sleep duration

following increased physical activity levels. However a majority of research on the connection between physical activity and sleep contradicts the current findings.

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## INTRODUCTION

According to Marcus (2004), children spend at least 50% of their life sleeping. The quantity and quality of this sleep influences their growth, development, and daily functioning (Honomichl, Goodlin-Jones, Burnham, Gaylor, & Anders 2002). Individuals with developmental disabilities often have difficulty getting quality sleep (Johnson, 1996), with approximately 44% of children with DS have a sleep problem ranging from frequent night time waking, waking up early in the morning, co-sleeping, and restlessness (Cunningham et al., 1986; R. Stores, & G. Stores, 1996a; R. Stores, G. Stores, & Buckley, 1996b; R. Stores et al., 1998). Children with ASD have been reported to have sleep problems including, difficulties settling in for bedtime, falling and staying asleep (Richdale & Schreck, 2009), and Children with ID have been reported to wake frequently and for longer durations throughout the night, which lowers their sleep efficiency (Anders, Losif, Schwichtenberg, Karen, & Goodlin-Jones, 2012). This restless sleep often results in overactive behavior during the day, frequent day-time naps, and excessive daytime sleepiness (Cotton & Richdale, 2009), and irritability and stereotypical behaviors, lethargy, and hyperactivity (Wiggs & Stores, 1996).

When children have sleep problems that negatively affect their daytime behaviors it is challenging for parents and teachers to use behavior modification techniques (Wiggs & Stores, 1996). As a result, it is difficult to teach children

behavior regulation strategies, which further inhibits the individual's ability to function appropriately in their daily lives (Wiggs & Stores, 1996). Additionally, individuals who have sleep disturbances are more likely to have diminished physical activity levels, which can contribute to potential risk for childhood obesity (Gupta, Mueller, Chan, & Meininger, 2002). On the other hand, children who are more physically active during the day tend to fall asleep faster and have a longer duration of sleep time (Nixon, et al. 2009).

The Centers for Disease Control and Prevention (CDC; 2015), defines regular physical activity for children and adolescents as 60 minutes of physical activity every day which should lead to health benefits. However, the U.S. report card for 2016 showed that approximately 80% of all children are not achieving the guidelines for moderate-to-vigorous physical activity (MVPA) per day (Katzmarzyk, et al. 2017). Moreover, individuals' with disabilities tend to engage in even less physical activity than their typically developing peers (Bedell et al., 2013). These low levels of physical activity engagement indicate that individuals' with disabilities may be missing out on the sleep benefits of physical activity as well as the larger health benefits of reducing risk of chronic disease and secondary health conditions, while also improving mental health, the ability to be self-sufficient, and build friendships (Bandini et al., 2005; CDC, 2018; Dykens, Rosner, & Butterbaugh, 1998; US Department of Health and Human Services, 2010).

Support from parents or caregivers can facilitate increased physical activity participation among individuals with disabilities. For example, they have been shown

to play a key role in modeling health behaviors including physical activity (Jeong, Kim, & Lee, 2015; Miklankova, Gorny, & Klimesova, 2016; Shen, et al., 2016; Tristani et al., 2017). However, barriers to facilitating physical activity for individuals with disabilities include lack of time, cost, availability of community programs, lack of knowledge on how to adapt physical activities for their charge, fear of injury, and social isolation (Erkelenz et al., 2014; Schleien et al., 2014; Shields, Synnot, Barr, 2012). Examinations of past programs that focused on getting families to engage in physical activity together provided evidence for their success in increasing family physical activity levels (Brunton, 2017). This evidence suggests that a family centred physical activity program could be effective in increasing physical activity engagement for children with disabilities and thus allow them to experience the health benefits associated with this activity including improved sleep quality



## LITERATURE REVIEW

### Sleep Patterns of Children with Disabilities

According to the CDC (2018) insufficient sleep is associated with an increased risk for chronic diseases and conditions, such as type 2 diabetes, cardiovascular disease, obesity, and depression. Approximately 34% of typically developing children experience sleep problems, such as difficulty falling asleep and frequent waking in the night (Mindell, 1993; Kahn et al., 1989; Morrison, McGee, & Stanton, 1992). The reported sleep problems in children with developmental disabilities are even higher, with approximately 65% of them having sleep difficulties which include difficulty falling asleep and frequent waking in the night (Richdale, 1999; Stores, 1992).

According to Bonuck, Blank, True-Felt, and Chervin (2016), poor quality sleep in early childhood results in impaired social-emotional and cognitive functioning, and increased risk for disease and chronic health conditions. Children who experience lower sleep duration are reported to have lower physical activity levels, increased screen time, and increased intake of fast foods resulting in higher rates of obesity when compared to children who received at least 8 hours of sleep per day (Garaulet, et. al., 2011). Children with developmental disabilities experience complications from lack of sleep including daytime challenging behaviors (Wiggs & Stores, 1996), overactive behavior during the day, frequent day-time naps, and excessive daytime sleepiness (Cotton & Richdale, 2009), and irritability and stereotypical behaviors, lethargy, and hyperactivity (Wiggs & Stores, 1996).

## Physical Activity and Sleep

Engaging in at least 150 minutes of moderate to vigorous physical activity (MVPA) per week reduces an individual's risk for chronic health conditions such as heart disease, cancer, type 2 diabetes, high blood pressure, osteoporosis, and obesity (Centers for Disease Control and Prevention, 2018). The National Sleep Foundation (2018), reports that physical activity results in better sleep at night by reducing arousal, anxiety and symptoms of depression. However, according to the United States Report Card on physical activity for children and youth 2016), 80% of children in the U.S. were not meeting physical activity guidelines. Children who participate in higher levels of MVPA increase their sleep duration, which could be a successful intervention for the sleep problems often experienced by individuals who have developmental disabilities (Ekstedt, Nyberg, Ingre, Ekblom, & Marcus, 2013).

Loprinzi, Cardinal, and Bradley (2011) found that adults between the ages of 18 and 85 who met the Physical Activity Guidelines for Americans, reported a 65% improvement in the quality of their sleep after 7 days and felt less sleepy during the day compared to those not meeting the national guideline. A number of studies have shown that long-term exercise increases sleep quality and duration, while decreasing sleep latency in adults without sleep disturbances (Kubitz, Landers, Petruzzello, Han, 1996; O'Connor, 1995; Youngstedt, O'Connor, Dishman, 1997). Youngstedt, et. al., (1997) found that endurance training in particular has a positive influence on sleep. Individuals who have been diagnosed with insomnia have found that physical activity significantly improves their sleep quality and reduces daytime sleepiness and symptoms of depression (Reid, et. al., 2010). Exercise has also been found to be an

effective treatment for those who experience sleep-disordered breathing (SDB) and obstructive sleep apnea. Iftikhar, Kline and Youngstedt, (2014) reported that physical activity engagement significantly reduced the severity of sleep apnea. Similarly, Kline, et. al., (2011) found that a 12-week moderate-intensity exercise routine resulted in a 25% reduction of sleep apnea severity. Physical activity engagement also improved sleep and daytime functioning, including depressive symptoms in participants who experience sleep apnea (Kline, et. al., 2012). The previous research suggests that physical activity could prove an effective non pharmacological treatment for sleep disturbances.

### Family Physical Activity Programs

Perceived barriers to physical activity for individuals' with disabilities included lack of knowledge and skills, individuals' preferences, fear, parental behavior, negative attitudes towards disability from society, inadequate facilities, lack of transport, lack of programmes and staff capacity, and cost. However, facilitators include the individual's desire to be active, practicing skills, involvement of peers, family support, accessible facilities, proximity of location, and skilled staff (Shields et. al., 2014). In rural locations individuals' face the same barriers, however they are more profound based on their rural residency (Wakely, Langham, Johnston, & Rae, 2017).

Researchers have shown that parents can be both barriers and facilitators to their child's physical activity levels. Beets, Cardinal and Alderman (2010), reported that parents who provided positive social support in the form of praise, transportation,

purchasing equipment, supervision, participation with, and discussing the importance of exercise had children who engaged in more physical activity. Similarly, when both parents are physically active, their children are more than five times as likely to be active compared to children whose parents are inactive (Cardinal & Alderman, 2010). Children whose mother is physically active are two times more likely to be active, and they are more than three times more likely to be active if only their father is physically active (Moore, et. al., 1991). This evidence suggests that a family physical activity program may increase physical activity levels in children who experience disabilities.

A family-centred program aiming to reduce obesity rates in children whose families are experiencing low-income, reported that children experienced weight loss, increased light physical activity levels and consumption of healthy foods, while decreasing screen time and sedentary behaviors (Davison, Jurkowski, Kaigang, Kranz, & Lawson, 2013). Additionally, parents reported greater confidence in their ability to promote healthy eating and increased physical activity levels in their children after the program. This family-centered program created the opportunity for parents to play an active and equal role with the researchers in implementing the intervention for their children (Davison et al., 2013). According to Baksjoberget, Nyquist, Moser, and Jahnsen (2017), children who experience disabilities can also benefit from family centred physical activity programs that focus on providing education and support to create adapted environment needed for children and their families to learn new skills. In their longitudinal study children with disabilities identified a goal that they wanted to work on. They participated in 4 individual and group based activities each day for 19 days. The activities focused on providing

education and support to create adapted environment needed for children and their families to learn new skills. After the 19 day in person intervention researchers examined the effects of their intervention over a 15 month period, and they found that children with disabilities experienced an overall increase in their physical activity levels compared to pre-intervention even though the intensity and diversity in activity decreased after the intervention portion of the study. Family participation plays a crucial role in their children's overall physical activity levels, and prove to be a key component in helping their children achieve the physical activity guidelines provided by the CDC (2015) and should be taken into consideration when working with children who experience disability.

## PURPOSE OF STUDY

The purpose of this study was to analyze the effects of participating in a family focused physical activity program on sleep patterns in an individual with Down syndrome. The researchers hypothesized that participants would increase their participation in physical activity over the duration of the program and the increased physical activity would correlate with delaying morning wake-up time during the program.

## METHODS

### Participants

Initially, 12 families participated in the Fit-fam program, however, only one family provided consistent data for the duration of the independent portion of the program. Therefore, the participant in this study included a 20 year-old with down syndrome and their parent who were involved in the Humboldt State University Family Fitness Program. The family was recruited from HSUfit, a Friday evening program in the spring semester that brings children with disabilities to campus for inclusive gym and pool activities. The participants were able to speak fluent English.

### Instruments/Measurements

For the duration of the family fitness program, the sleep quality and patterns of each family member were self-reported, with parent proxy reporting of youth sleep, once a week using Google Forms. The recording form is included in appendix A. The online report had the family input the duration and quality of sleep and minutes of MVPA per day. The final weekly report was used to represent post-program sleep quality and pattern levels.

### Procedures

The family participated in a summer physical activity program (Humboldt State Family Fitness Program). The Family Fitness Program consisted of two phases.

Phase one included one week of in-person programming, and phase two, consisted of eight weeks of independent physical activity. During the week-long summer program, the individual with a disability participated in a physical activity program that focused on social emotional behaviors and developing skills and abilities to improve motor performance and physical activity/fitness. Additionally, the parent of the individual participating met for 30 minutes a day to receive instruction in how to support their child's engagement in home and community based physical activities. This instruction included how to modify activities and equipment to meet their child's needs, finding accessible physical activity opportunities in the community, setting physical activity goals for the family and child, and overcoming barriers to activity.

At the end of the weeklong in-person program, the parent was provided a physical activity plan for the summer based on the results of their child's fitnessgram to facilitate physical activity engagement for their children for the duration of the study. During the six weeks of self-directed activity, parents logged the activities that each member of the family engaged in including the duration and perceived intensity level of the activity and the duration and quality of sleep. These logs were submitted to the researcher on a weekly basis, electronically through Google Forms. At the end of each week, the parent was sent a reminder to fill in and return the weekly logs. To protect anonymity, the participants were given an ID code to use on their report so that trends could be tracked for the participant but no directly identifying information was included in the data.

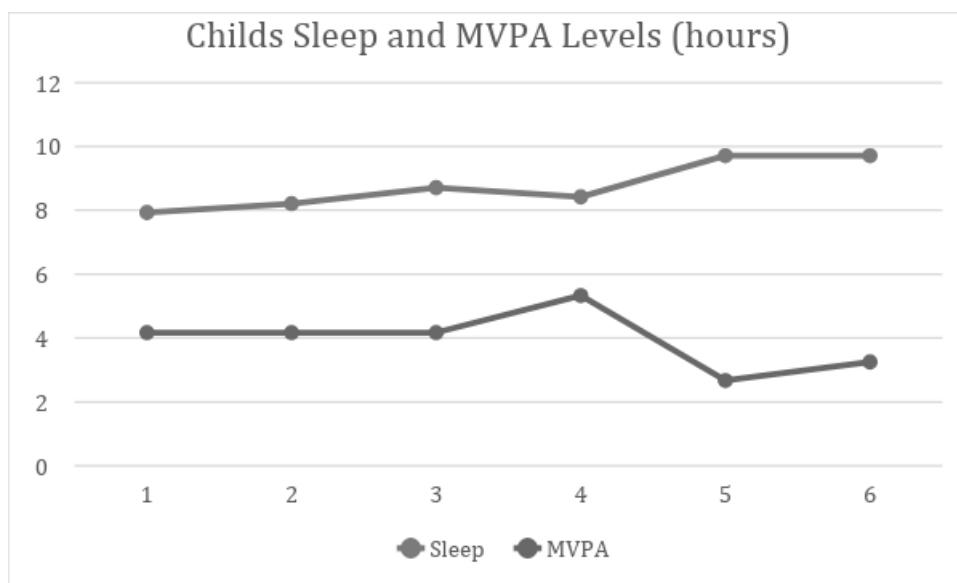
## Analysis



To examine change over time of sleep duration and quality and compare this to trends in physical activity, the weekly totals are displayed in a line graph.

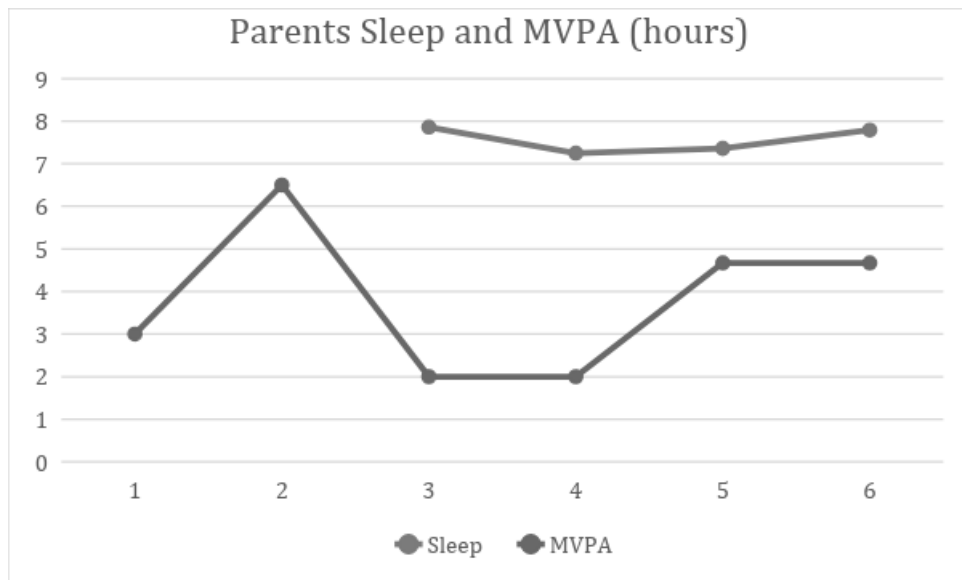
## RESULTS

Analyses focused on participants' engagement in moderate to vigorous physical activity (MVPA) and the effect MVPA has on hours of sleep over a 6 week period. Participants recorded the minutes of MVPA (see figure 1 below) and the number of hours of sleep (see figure 2 below) for both the adult (Participant P) and the child (Participant C).



*Figure 1: Comparison of Sleep and Moderate to Vigorous Physical Activity for the Child*

For the child, there was an inverse relationship between MVPA and hours of sleep. For the first three weeks, MVPA and sleep time were relatively stable and then as physical activity decreased over weeks five and six, sleep increased.



*Figure 2: Comparison of Sleep and Moderate to Vigorous Physical Activity for the Parent*

For the parent, there was no discernible pattern for physical activity and sleep over the duration of the program.

## DISCUSSION

The purpose of this study was to analyze the effects of participating in a family focused physical activity program on sleep patterns in individuals with Down syndrome. The researchers hypothesized that through the program, participants would increase their participation in physical activity, which would improve their sleep latency and efficiency while delaying morning wake-up time during the program. The results from the current case study do not support this hypothesis, however, these results coincide with the findings from Pesonen et al., (2011), who found that increased PA during the day was associated with decreased sleep quality during the same night, and poor sleep during the night was associated with increased PA the following day. Unlike the current study Pesonen et al., (2011) used accelerometers to measure PA and sleep, which has been shown to be a more accurate measure compared to parent-report (Hodge, Parnell, Hoffman, Sweeney 2012). In contrast, Wachob and Lorenzi (2015) used accelerometers to measure physical activity and sleep quality, and found that the more physical activity the participants engaged in, the higher the overall sleep quality they experienced was, which contradicts the current study's findings that when children increase the minutes of MVPA participation per week, their hours of sleep decrease. The majority of previous research has shown that children who are more physically active during the day fall asleep faster and have a longer duration of sleep time than children who participate in

less physical activity (Bandini et al., 2005; CDC, 2018; Dykens, Rosner, & Butterbaugh, 1998; US Department of Health and Human Services, 2010).

One explanation for the current study's findings is that all data was self-reported. Recall bias may have influenced the results of the study in that parents may not have accurately reported the minutes of MVPA or the duration of sleep. Previous research has found discrepancies between accelerometry and self-reported physical activity and sleep time (Colley et al., 2012). Parents report on the time the child spent on the activity, while the accelerometer measures actual movement at a defined intensity. Similarly, parents report longer sleep duration possibly because they are reporting on the sleep latency to when their child wakes. Additionally, Hodge, Parnell, Hoffman, & Sweeney (2012), found that while parent-report is an effective measure for sleep latency, video somnography (VSG) is an accurate and objective measure for recording sleep behaviors. The current study did not include a supplemental objective form of measurement for accurately reporting the hours and quality of sleep of participants. Future studies should incorporate objective measurements of physical activity and sleep time and include more face-to-face program time between participants and program facilitators to improve fidelity to the prescribes physical activity program.

## CONCLUSION

The quantity and quality of sleep during childhood influences growth, development and daily functioning (Marcus, 2004). Moreover, individuals with developmental disabilities report having more sleep disturbances, which effects their daily functioning and behavior, and puts them at greater risk for obesity (Johnson, 1996). Individuals who meet physical activity recommendations experience health benefits of physical activity including improved sleep quality (CDC, 2015). While the majority of Americans do meet physical activity recommendations, individuals with developmental disabilities engage in even less MVPA than their typically developing peers (Bedell et al., 2013). While parents and guardians play an important role in increasing their child's physical activity levels, parents of children who have developmental disabilities reported that various barriers hinder their ability to facilitate physical activity, such as, cost, lack of time, lack of available inclusive programs, fear of injury, social isolation, and lack of knowledge on how to adapt physical activities for their children (Erkelenz et al., 2014; Schleien et al., 2014; Shields, Synnot, Barr. 2012). The current study attempted to mitigate the barriers to physical activity by incorporating parents into an educational program providing parents with the knowledge and skills to facilitate independent physical activity engagement of their child. Through engagement in this program, it was expected that children would increase their physical activity levels which would in turn improve their sleep quality. The results of this study found that the participants increased

physical activity levels, decreased the duration and quality of their sleep during the program. While a few other studies found similar results, a majority of studies found a positive relationship between physical activity levels and sleep. While the current study was a family centered program, parents did not participate in physical activity with their child during phase one of the program, instead they attended a 30 minute session to develop a plan for phase 2 of the program. Future research might consider involving parents in physical activities with their children, where they can have hands on experience facilitating physical activity with their children that they can generalize to their home environment.

#### Limitations

The limitations of this study included the reliance on self-report for accurate and consistent reporting of sleep latency, waking and sleep efficiency, and physical activity type and duration.

#### Delimitations

The delimitations of the study includes only allowing families with a child with a disability to participate in the program and the families of the children being proficient English speaker and writers in order to report on their child's sleep quality and physical activity levels.

## Assumptions

The assumptions of the study are that the parent provided accurate and honest reporting of outcomes and that the family followed their physical activity plans that they created during the one week in-person portion of the program.



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## APPENDIX

## Weekly Activity Log

Day	Activity	How Long	Intensity*	Hours of sleep	Quality of sleep*
Monday					
Adult 1					
Adult 2					
Child 1					
Child 2					
Child 3					
Tuesday					
Adult 1					
Adult 2					
Child 1					
Child 2					
Child 3					
Wednesday					
Adult 1					
Adult 2					
Child 1					
Child 2					
Child 3					
Thursday					
Adult 1					
Adult 2					
Child 1					
Child 2					
Child 3					
Friday					
Adult 1					
Adult 2					
Child 1					
Child 2					
Child 3					
Saturday					
Adult 1					
Adult 2					
Child 1					
Child 2					
Child 3					
Sunday					
Adult 1					
Adult 2					

Day	Activity	How Long	Intensity*	Hours of sleep	Quality of sleep*
Child 1					
Child 2					
Child 3					

\*For intensity, please use the following scale: 1 = slow/easy, 2 = medium/moderate, 3 = fast/very fast

For quality of sleep, please use the following scale: 1 = Woke up many times during the night, 2 = woke up few times during the night, 3 = did not wake up during the night