Published in final edited form as:

J Intellect Disabil Res. 2016 January ; 60(1): 68–79. doi:10.1111/jir.12236.

Sleep problems and associated comorbidities among adults with Down syndrome

Anna J. Esbensen, PhD

Cincinnati Children's Hospital Medical Center

Abstract

Background—Sleep problems, including sleep apnoea and behavioural sleep disturbances are common among adults with Down syndrome (DS). Despite a preliminary understanding of potential medical and behavioural comorbidities of these sleep problems among children with DS, little is known about comorbid conditions associated with these sleep problems among adults with DS. Understanding causes and sequelae of sleep problems in this aging population is essential to providing quality health screening, and treatment. The current study examines the physical health problems, mental health conditions, functional abilities and behavioural problems associated with sleep apnoea and behavioural sleep disturbances among adults with DS.

Method—Family caregivers participated in clinical interviews and completed questionnaires, providing reports regarding 75 adults with DS. Caregivers reported on sleep problems, physical and mental health conditions, daily living skills and behaviours regarding their aging family member with DS.

Results—Sleep apnoea was associated with more common other respiratory concerns, and more frequent visits to physicians, but not with some expected medical comorbidities (cardiac). Behavioural sleep disturbances (delayed sleep onset, night-time awakenings, morning awakenings) were associated with poorer health, more frequent overnight hospital and emergency department visits, more common cardiac conditions, less common thyroid condition, more common mental health conditions (anxiety, depression, dementia), and a higher rate of daytime behaviour problems.

Conclusion—The study findings suggest that there are differential correlates for the various sleep problems in adults with DS, which warrant attention when screening for medical and mental health comorbidities, assessing behavioural problems, and in treatment planning for aging adults with DS.

Keywords

Aging; comorbidities; Down syndrome; sleep apnoea; sleep disturbances

Adults with Down syndrome (DS) display premature age-related changes in their health. They are also at high risk for conditions as they age, including dementia, early-onset

menopause, thyroid dysfunction, diabetes, hair and skin changes, visual and hearing impairments, obesity, musculoskeletal problems and sleep apnoea (as reviewed in Esbensen, 2010). Despite the increased risk for these health conditions, adults with DS are currently experiencing longer life spans, likely secondary to better health care, health care knowledge, advocacy and services (Yang, Rasmussen & Friedman, 2002). With these advances comes the responsibility to better support the needs of this population as it ages. Sleep problems are a unique area of concern in that they are very common in individuals with DS of all ages, and they can be both a primary cause of symptoms (mood changes, behaviours) and a consequence of health problems (obesity).

A common sleep problem in DS is obstructive sleep apnoea. Obstructive sleep apnoea involves an obstruction of the upper airway and affects 31–63% of individuals with DS (de Miguel-Díez, Villa-Asensi, & Álvarez-Sala, 2003; Marcus, Keens, Bautista, von Pechman & Ward, 1991; Stebbens, Dennis, Samuels, Croft, & Southall, 1991). Certain facial and physical features contribute to the increased risk, including midfacial hypoplasia, mandibular hypoplasia, glossoptosis (retraction or downward displacement of tongue), an abnormally small upper airway, superficially positioned tonsils, relative tonsillar and adenoidal encroachment, and hypotonia of the upper airway (Marcus et al., 1991; Roizen & Patterson, 2003). Two health conditions common in adults with DS further contribute to the increased risk for obstructive sleep apnoea: obesity and hypothyroidism (Rajagopal et al., 1984; Trois et al., 2009). Recently, age has been considered as a possible risk factor for obstructive sleep apnoea given its association with obesity and hypothyroidism, although findings are mixed (Resta et al., 2003; Telakivi et al., 1987; Trois et al., 2009).

Behavioural sleep disturbances are also pervasive in DS, with difficulties with sleep initiation, sleep maintenance, sleep anxiety, and early waking being reported in 52–69% of children with DS (Carter, McCaughey, Annaz, & Hill, 2009; Epstein, Pillar, Tzichinsky, Here, & Lavie, 1992; Rosen, Lombardo, Skotko, & Davidson, 2011; Stores & Stores, 1996). Some aspects, but not all, of behavioural sleep disturbances are suspected to be lower among adolescents than among younger children, such as the frequency of night wakings (Carter et al., 2009), although there are limited reports of their prevalence among adults with DS. Among adults with intellectual and developmental disabilities (IDD), sleep problems are reported to vary from 13–86% of adults, depending on the ages examined (Brylewski & Wiggs, 1998; Didden & Sigafos, 2001). Given the high rates of behavioural sleep disturbances among children with DS, it is important to take into account these behavioural sleep disturbances, in addition to obstructive sleep apnoea, when examining outcomes related to sleep among adults with DS.

Both obstructive sleep apnoea and behavioural sleep disturbances are associated with negative outcomes, both physical and behavioural. In the general population, obstructive sleep apnoea is associated with physical conditions (hypertension, pulmonary hypertension, increased heart disease, poor glucose tolerance), mental health concerns (dementia, anxious and depressed symptoms) and can also contribute to inattention, hyperactivity, daytime drowsiness, and oppositional behaviours (Aloia, Ilniczky, di Dio, Perlis, Greenblatt & Giles, 2003; Beebe, 2006; Beebe, 2011; Bliwise, 1993; Saunamäki & Jehkonen, 2007). Consistent with findings from typically developing children, recent studies in DS have supported the

association between obstructive sleep apnoea and inattention, impulse control, and difficulties with daytime functioning, cognitive abilities, mood and behaviour regulation (Breslin, Spanò, Bootzin, Anand, Nadel & Edgin, 2014). Also consistent with the general population, adults with DS with obstructive sleep apnoea have more difficulties with visuoperceptual tasks (Andreou, Galanopoulou, Gourgoulisanis, Karapetsas & Molyvdas, 2002). Sleeping difficulties are also increasingly likely in adults with DS as they progress through the stages of dementia (Cooper & Prasher, 1998; Urv, Zigman & Silverman, 2010). In contrast, despite the increased risk for obstructive sleep apnoea in adults with DS, hypertension and heart disease are uncommon problems for this population in general (Haveman, Maaskant & Sturmans, 1989; Kerins, Petrovic, Bruder & Gruman, 2008; Marino & Pueschel, 1996; Prasher 1994; Yang et al., 2002). Given the inconsistency of comorbidities related to sleep problems in adults with DS when compared to their typically developing peers, there is a need to better understand the physical and behavioural concerns secondary to obstructive sleep apnoea in this population.

Behavioural sleep disturbances are associated with inattention, impulse control, and difficulties with daytime functioning, cognitive abilities, mood and behaviour regulation in the general population (Balkin et al., 2008; Doran et al., 2006; Fallone, Owens & Deane, 2002; Paavonen, Porkka-Heiskanen & Lahikainen, 2009a, Paavonen et al., 2009b; Steenari, Vuontela, Paavonen, Carlson, Fjalberg & Aronen, 2003). Though less extensively studied among individuals with IDD, a comparable impact of behavioural sleep disturbances has been found in this population as in the general population (Malow, Marzec, McGrew, Wang, Henderson & Stone, 2006; Montgomery, Stores & Wiggs, 2004; Richdale & Wiggs, 2005, Stores & Wiggs, 2001). Increased rates of irritability, hyperactivity, stereotypy, aggression, self-injury and screaming are reported among adults with IDD and comorbid sleep problems as compared to those without sleep issues (Brylewski & Wiggs, 1999). In small sample studies among school-age children with DS, behavioural sleep disturbances were associated with both daytime dysfunction (irritability and over-activity), executive functioning (attention and reaction time), and with reduced parental well-being (Ashworth, Hill, Karmiloff-Smith & Dimitriou, 2013; Cotton & Richdale, 2010; Stores, 1993; Stores, Stores, Fellows & Buckley, 1998). It is still not well understood how behavioural sleep disturbances directly influence outcomes for individuals with DS, and very little is empirically documented about outcomes for adults with DS.

Given the prevalence of both sleep apnoea and behavioural sleep disturbances, this study aimed to provide a preliminary understanding of potential comorbidities and medical and behavioural outcomes among adults with DS. Specifically, we aimed to explore the relationship between sleep problems among adults with DS and other factors, including physical and mental health, functional abilities and behaviour problems. First, we aimed to describe the frequency of various sleep problems, including sleep apnoea and behavioural sleep disturbances, based on family reports of medical conditions and sleep behaviours. Second, we explored the relationship between identified sleep problems and physical health problems. We hypothesized that sleep problems (sleep apnoea, behavioural sleep disturbances) would be related to worse physical health problems and more frequent physician visits. Third, we explored the relationship between identified sleep problems and mental health conditions. We hypothesized that sleep problems (sleep apnoea, behavioural

sleep disturbances) would be related to the presence of mental health conditions. Fourth, we explored the relationship between identified sleep problems and functional abilities and behaviour problems. We hypothesized that sleep problems (sleep apnoea, behavioural sleep disturbances) would be related to lower functional abilities and greater behaviour problems. Understanding the extent to which sleep problems influences outcomes will help support behavioural interventions, medical care, and support aging among adults with DS.

Method

The current study is based on a subsample drawn from a larger longitudinal study of families of adults with IDD in Wisconsin and Massachusetts ($n = 461$). The primary purpose of this prior study was to assess the impact on aging caregivers, of caring for an adult with IDD. Initial recruitment criteria for families to enrol in the larger longitudinal study was having a mother age 55 and older whose adult son or daughter with IDD was living at home (Esbensen, Mailick, & Silverman, 2013; Esbensen, Seltzer, & Krauss, 2011; Krauss & Seltzer, 1999; Seltzer, Krauss, Hong & Orsmond, 2001). Of the original sample, 169 mothers had a son or daughter with DS. From 1988 to 2000, eight waves of data were collected at 18 month intervals. A ninth wave of data collection was conducted a decade later (2010/2011), in which 75 of the original families participated. The primary purpose of this follow-up study was to examine the aging of adults with DS. The adult with DS reported on by these 75 families forms the sample for the present analysis. The initial and current studies were both approved by the Institutional Review Board at the University of Wisconsin-Madison.

Participants

Adults with DS were primarily male (65.3%), had mild or moderate IDD (74.7%) and ranged in age from 37 to 65 years ($M = 51.1$, $SD = 6.0$) at the time of most recent data collection. The remainder of the adults had severe or profound IDD. All adults were Caucasian, and 34.7% of adults with DS lived with a family member.

Respondents were all family members and included mothers (44.0%), sisters (33.3%), brothers (13.3%) and fathers (9.3%). As a result, 77.3% of respondents were female. The respondents ranged in age from 39 to 97 years ($M = 73.4$, $SD = 13.6$).

Measures

Caregivers participated in clinical interviews to collect information from the Dementia Scale for Down Syndrome (DSDS), Dementia Questionnaire for People with Learning Disabilities (DLD), and the Psychiatric Assessment Schedule for Adults with Developmental Disabilities (PAS-ADD; Evenhuis, Kengen, & Eurlings, 2006; Gedy, 1995; Moss, 2002). All other data were collected by caregiver completed questionnaires.

Sleep—We categorized sleep problems into two categories; sleep apnoea and behavioural sleep disturbances. Individuals with DS were then categorized as (1) having or (0) not having the specified sleep condition.

Sleep apnoea included individuals with DS identified from caregiver report as (1) having a current medical diagnosis (within the last year) of sleep apnoea, in comparison to (0) not having sleep apnoea. Data were not collected on treatments for sleep apnoea. Although having adults with DS participate in a sleep study would be ideal in diagnosing sleep apnoea, such a screen was cost-prohibitive for the nature of this longitudinal across-state study of aging adults with DS. Caregiver reports have previously been used to categorize sleep apnoea in adults with genetic conditions (Maas et al., 2010).

Behavioural sleep disturbances were identified based on caregiver report using clinical interviews of the PAS-ADD and DLD (Evenhuis, Kengen, & Eurlings, 2006; Moss, 2002). From the PAS-ADD, caregivers reported if the adult slept less than usual, experienced a delay in getting to sleep, woke early, exhibited broken sleep or had a lack of energy. These behaviours were recorded based on initial probe questions in the PAS-ADD for the presence or absence of each sleep disturbance. From the DLD, caregivers reported if the adult was always awake during the night. If any one of these difficulties with sleep were reported, the adult was coded as (1) having a behavioural sleep disturbance rather than (0) not having a behavioural sleep disturbance. Both the PAS-ADD and DLD (or its prior edition) have been used in screening for behavioural sleep disturbances (Boyle et al., 2010; Cooper & Prasher, 1998; Urv, Zigman, & Silverman, 2008).

Physical health conditions—Current health status of the adult with DS was rated on a 4-point scale (1 = poor, 2 = fair, 3 = good, 4 = excellent). Higher scores indicate better health. Such global ratings of health have been found to be accurate measures of health status (Idler & Benyamini, 1997).

The frequency of physician or emergency department visits in the last year was reported by family members, as well as whether or not the adult with DS had experienced an inpatient stay.

In addition, an 8-item scale was used to measure the (1) presence or (0) absence of health conditions in the past year. Items include respiratory/lung, thyroid, dental, cardiac/blood, sensory, gastro-intestinal, pain/joints/bones, or other internal organs. Sleep apnoea was *not* included in the classification of respiratory/lung conditions to avoid potential overlap.

Mental Health—An 8-item scale was used to measure the (1) presence or (0) absence of current mental health diagnoses, including anxiety, obsessive-compulsive disorder, post-traumatic stress disorder, attention-deficit hyperactivity disorder, bipolar disorder, depression, oppositional defiant disorder or schizophrenia.

Dementia status was classified using consensus coding between two licensed clinical psychologists blind to the predictor variables. Details of consensus coding have been outlined elsewhere, and were based on data collected through the DLD, the DSDS, and the PAS-ADD (Esbensen, Seltzer & Silverman, 2013; Evenhuis, Kengen, & Eurlings, 2006; Gedy, 1995; Moss, 2002). Dementia status was categorized as (0) no dementia or (1) possible or definite dementia. Initial coding resulted in 89% agreement among the psychologists. Further discussion resolved any disagreements.

Daily Living—The Waisman Activities of Daily Living (W-ADL) Scale for adolescents and adults with developmental disabilities was used to measure functional abilities as based on the level of performance of common daily activities (Maenner, Smith, Hong, Makuch, Greenberg, & Mailick, 2012). The 17-item scale is rated on a 3-point scale (0 = “does not do at all”, 1 = “does with help”, 2 = “independent”), and items summed to produce a total score. Higher scores indicate better functional abilities.

The Scales of Independent Behaviour – Revised (SIB-R) was used to measure the frequency and severity of eight types of behaviour problems, in order to provide an overall measure of generalized behaviour problems and three subscales: Internalized Maladaptive Behaviour (hurtful to self, unusual or repetitive habits, and withdrawn or inattentive behaviour), Asocial Maladaptive Behaviour (socially offensive behaviour and uncooperative behaviour), and Externalized Maladaptive Behaviour (hurtful to others, destructive to property, and disruptive behaviour) (Bruininks, Woodcock, Weatherman, & Hill, 1996). Individual problem behaviours were scored as present or absent. Index scores provided ratings of the seriousness of the problem behaviour as sub-clinical (90–110), marginally serious (111–120), moderately serious (121–130), serious (131–140) or very serious (141 or above). Reliability and validity were excellent (Bruininks et al., 1986).

Data Analysis

We assessed for potential differences between sleep groups (having or not having sleep apnoea, and having or not having behavioural sleep disturbances) on demographic variables of gender, level of IDD, age and residential placement. Level of IDD was determined by cognitive testing with the Stanford-Binet 4th Edition. If cognitive testing could not be completed due to floor effects, level of IDD was confirmed from agency records and parental report. Identified covariates were included in subsequent analyses.

To address the first research aim, which aimed to describe the frequency of various sleep problems, we used descriptive statistics to assess the frequency of sleep apnoea, and behavioural sleep disturbances.

To address the second research aim, which concerned the relationship between identified sleep problems and physical health problems, ANCOVAs were used to contrast the sleep groups with respect to the ratings of health and the frequency of health related visits. Chi-square tests were used to contrast the sleep groups with respect to the presence or absence of comorbid health problems.

To address the third research aim, which concerned the relationship between identified sleep problems and mental health conditions, chi-square tests were used to contrast the sleep groups with respect to the presence or absence of comorbid mental health problems.

To address the fourth research aim, which concerned the relationship between identified sleep problems and functional abilities and behaviour problems, ANCOVAs were used to contrast the sleep groups with respect to the ratings of functional abilities and the severity ratings of behaviour problems.

Results

Frequency of Sleep Problems

Almost a third (30.7%) of the sample was identified as having any sleep problem. This included 13.3% identified with sleep apnoea, and 22.7% identified as having behavioural sleep disturbances. Behavioural sleep disturbances included 17.3% classified from responses on the PAS-ADD, and 6.9% classified from responses on the DLD, as always being awake during the night. Demographics of the adults included in each sleep category are presented in Table 1. Three individuals were omitted from comparisons regarding sleep apnoea due to missing data on caregiver reports regarding medical diagnoses.

Covariates

Adults with sleep apnoea did not significantly differ by age from adults without sleep apnoea. However, adults with behavioural sleep disturbances were older than adults without behavioural sleep disturbances, $t(73) = -3.92, p < .001$ (see Table 1).

Adults with sleep apnoea were significantly more likely to be higher functioning than adults without sleep apnoea, $\chi^2(1) = 4.2, p < .05$ (see Table 1). Adults with behavioural sleep disturbances were not significantly different from adults without sleep problems based on their level of functioning. No gender differences or differences in residential placement were present between individuals with sleep apnoea or behavioural sleep disturbances in comparison to not having sleep problems.

Based on these analyses, subsequent ANCOVAs controlled for level of functioning in analyses based on sleep apnoea, and controlled for age in analyses based on behavioural sleep disturbances. As all individuals with sleep apnoea fell in the mild/moderate IDD group, chi-square analyses were limited to adults with mild/moderate IDD when comparing those with and without sleep apnoea. When controlling for age in chi-square tests, groups were split based on the mean age of the entire sample, with analyses conducted separately for adults younger than 50 years, and for those 51 years of age and older.

Relationship to Health Conditions

With regard to general health, adults with DS and behavioural sleep disturbances were found to differ significantly from those without behavioural sleep disturbances, $F(1,70) = 13.53, p < .001$. Adults with behavioural sleep disturbances were in worse current health than those without sleep problems (see Table 2). No statistically significant differences were observed between adults with DS with or without sleep apnoea regarding current health status.

With regard to health care visits, adults with sleep apnoea were reported to have more frequent visits to their physician than adults with no sleep apnoea, $F(1,69) = 4.19, p < .05$ (see Table 2). Overnight stays in the hospital, $F(1,70) = 6.02, p < .05$, and visits to the emergency department, $F(1,70) = 12.21, p < .001$, were reported more frequently among adults with behavioural sleep disturbances than adults with no behavioural sleep disturbances.

The percentage of adults with comorbid physical health conditions is detailed in Table 3, by those with and without sleep apnoea, and by those with and without behavioral sleep disturbances.

With regard to types of health conditions, analyses revealed significant differences for the presence of comorbid respiratory conditions among adults with mild/moderate IDD and sleep apnoea, $X^2(1) = 4.28$, $p < .05$, but not for adults with behavioural sleep disturbances. Adults with sleep apnoea (30.0%) were more likely to have respiratory problems than adults with no sleep apnoea (7.0%).

Significant differences were found for the presence of thyroid problems among adults aged 51 and older with DS and behavioural sleep disturbances, $X^2(1) = 5.92$, $p < .05$. Thyroid problems are less likely among older adults with behavioural sleep disturbances (7.1%) than among adults with no behavioural sleep disturbances (45.5%).

Differences were also found for the presence of cardiac problems among adults aged 50 and younger with behavioural sleep disturbances, $X^2(1) = 10.56$, $p < .01$, with younger adults with behavioural sleep disturbances (66.7%) having more cardiac problems than adults with no behavioural sleep disturbances (5.9%).

No statistically significant differences were observed between adults with DS with or without sleep apnoea, or with or without behavioural sleep disturbances, in regards to the comorbidity of dental concerns, sensory concerns, gastro-intestinal concerns, joint pain or other internal organ problems.

Relationship to Mental Health

The percentage of adults with comorbid mental health conditions is detailed in Table 3, by those with and without sleep apnoea, and by those with and without behavioral sleep disturbances.

Comorbid clinical diagnoses of depression, $X^2(1) = 5.14$, $p < .05$, and anxiety, $X^2(1) = 5.14$, $p < .05$, were more common among adults with DS aged 51 and older with behavioural sleep disturbances (21.4% for both depression and anxiety) than among adults with no behavioural sleep disturbances (0.0% for both depression and anxiety).

Any mental health diagnosis, $X^2(1) = 10.22$, $p < .01$, was more common among adults with DS aged 51 or older with behavioural sleep disturbances (50.0%) than among adults with no behavioural sleep disturbances (4.5%).

Comorbid diagnoses of dementia, $X^2(1) = 11.24$, $p < .01$, were more common among adults with DS aged 50 and younger with behavioural sleep disturbances (66.7%) than among adults with no behavioural sleep disturbances (33.3%).

Relationship to Daily Living Outcomes

Adults with behavioural sleep disturbances were reported to have more generalized behaviour problems, $F(1,69) = 7.11$, $p < .01$, and more asocial behaviour problems, $F(1,69) = 7.31$, $p < .01$, than adults with no behavioural sleep disturbances (see Table 2). No

significant differences were found in the frequency of behaviour problems among adults with DS with or without sleep apnoea.

No significant differences were found in the level of functional abilities between adults with DS with or without sleep apnoea, or with or without behavioural sleep disturbances.

Discussion

Sleep apnoea and behavioural sleep disturbances were associated with several aspects of aging among adults with DS, including physical and mental health, and behaviour problems. However, the type of associated concerns with aging was specific to the type of sleep problem, with differential findings for sleep apnoea and behavioural sleep disturbances.

As expected, sleep apnoea was associated with a higher rate of respiratory concerns, and this finding was particularly the case among adults with DS with mild to moderate IDD. As questions of sleep apnoea were asked independently of respiratory concerns, this finding indicates that in addition to difficulties with oxygenation during the night, these adults are also having some difficulty with breathing during the day. Despite current health ratings being comparable across individuals with and without sleep apnoea, and no other health conditions being associated with sleep apnoea, these adults with sleep apnoea were visiting their physician at a rate twice that of their peers without sleep apnoea. The reasons for the physician visits were not obtained in this study, but raise questions on what is contributing to this need for more frequent medical care. As there were no differences in need for overnight or emergency visits, it is speculated that adults with DS, sleep apnoea and respiratory concerns are potentially seen by physicians and specialists more frequently for routine care than those without sleep apnoea.

In contrast to the literature among typically developing adults (Aloia et al. & Giles, 2003; Saunamäki & Jehkonen, 2007), sleep apnoea was not significantly associated with cardiac concerns, including hypertension, with mental health concerns or with oppositional behaviours among adults with DS. The current study did not assess treatment for sleep disorders. Although adherence to treatments for sleep apnoea in the general population are low (~18%; Wild, Engleman, Douglas & Espie, 2004), it is possible that the decreased risk for negative outcomes may be related to higher adherence to sleep interventions among adults with DS (35%; Trois et al, 2009). Given the small sample of adults reported as having sleep apnoea in this sample, these findings are best considered preliminary and warrant replication prior to modifying health care guidelines for individuals with DS (Bull, 2011; Cohen, 2002). Appropriate treatment of sleep apnoea may also contribute to the non-significant findings. Physicians are encouraged to continue monitoring for these standard side effects.

Behavioural sleep disturbances were common in over a fifth of the sample, and were associated with poorer health, more common physical health conditions, and more mental health conditions. Specifically, adults with behavioural sleep disturbances were more likely to have worse ratings of current health, more frequent overnight visits to hospital and visits to the emergency department. These health care differences may be related to findings that

these adults with behavioural sleep disturbances also had higher rates of current cardiac concerns. The rate of cardiac concerns among those with behavioural sleep disturbances is consistent with that in the general population, but is much higher than anticipated from the lower risk generally reported for adults with DS (Shahar et al., 2001; Van Allen, Fung & Jurenda, 1999), and not accounted for by congenital anomalies. Cardiac concerns included in this category were heart disease, stroke, hypertension, anaemia and cardiac abnormalities. Cardiac abnormalities were the most commonly reported in the sample, but all concerns were present within this group of individuals with behavioural sleep disturbances. Congenital heart conditions, common among children with DS, were excluded from the list of cardiac concerns. These findings highlight the importance of screening for cardiac concerns among adults identified by family or support staff to have behavioural sleep disturbances, particularly in younger adults as this finding was strongly driven by differences in adults under the age of 50 years. It also highlights the need for monitoring of sleep, potentially with polysomnograph sleep studies to appropriately determine how sleep may be contributing to cardiac concerns.

The lower rate of thyroid problems among adults with behavioural sleep disturbances is an unexpected finding. Generally hypothyroidism overlaps with obstructive sleep apnoea and sleep-disordered breathing (Pelttari et al., 1994). As information on the treatment of hypothyroidism is not available, any explanation regarding the cause for this finding is speculative. Regardless of the cause for the difference, replication is warranted, and the findings are suggestive of the need for ongoing vigilance in the treatment of thyroid problems in aging adults with DS.

Adults with behavioural sleep disturbances were also more likely to have comorbid mental health diagnoses than adults without behavioural sleep disturbances. Specifically, clinical diagnoses of anxiety or depression were more common, particularly among adults over the age of 50 years. As symptoms of these conditions include changing sleep patterns, withdrawal and lack of energy, the overlap is not unexpected. However, changes in sleep patterns and energy levels would not be sufficient for a clinical diagnosis. Further, sleep disturbances can contribute to the development of anxiety. These findings indicate the need for screening for mental wellness among adults with DS identified by family or support staff as having behavioural sleep disturbances, especially among adults over the age of 50. Behavioural sleep disturbances were associated with higher rates of dementia in the younger age group. With the progression of dementia, changes in sleep patterns and difficulty sleeping can become more common (Cooper & Prasher, 1998; Urv, Zigman & Silverman, 2010). Hence, our findings are consistent with previous studies linking behavioural sleep disturbances and dementia, and provide an indication of the pervasiveness of sleep concerns among aging individuals with dementia.

While behavioural sleep disturbances were not associated with functional abilities among adults with DS, a higher rate of behaviour problems was reported among these adults than among those with no behavioural sleep disturbances. This higher rate of behaviour problems was primarily observed in the asocial behaviours, which include socially offensive behaviours, withdrawn behaviours, inattention, and uncooperative behaviours. These findings are comparable to those in the general population, where sleep problems are

associated with inattention and decreased concentration (Nebes, Buysse, Halligan, Houck & Monk, 2009). It also appears that a poor night's sleep negatively impacts the ability of adults with DS to be compliant with task requests, and to curb the impulse to engage in inappropriate behaviours. These findings have substantial implications for behaviour support plans, functional behaviour assessments, and would be of interest to adult behaviour specialists. Specifically, the findings highlight the importance of ruling out a sleep problem as a contributor to worsening rates of noncompliance or other behaviours of concern in an adult with DS.

The number of individuals with DS with sleep problems reported in this sample was fewer than expected from previously reported prevalence rates. This lower rate may be attributed to using caregiver report and not an objective measure of sleep or medical review. Parent-reports of sleep disturbance and symptoms of sleep apnoea in children with DS have not been consistent with polysomnographs or actigraphy reports of sleep (Ashworth et al., 2013; Shott, Amin, Chini, Heubi, Hotze, & Akers, 2006). Given this lower rate, findings may be an underestimate of associated concerns and replication is warranted, taking into consideration sleep treatments. Future research is also needed to determine the direction of the relationship between sleep and associated conditions. The presence of behavioural sleep disturbances should serve as a red flag to family and care providers to screen for additional conditions. Sleep issues may be caused by an underlying health problem, or they may be contributing to the presentation of behavioural concerns. A limitation of the study is that current treatments were not reported, making it difficult to ascertain how the presence or absence of treatment is impacting current findings. Similarly, the presence of other medical conditions and behavioural concerns should serve as a red flag to screen for sleep disturbances, which are often under-identified by caregivers.

While the current sample was originally all living with their parents in 1988, most have moved out of the family home. While co-residence was not the norm when these aging adults with DS were born (between 1940s to 1970s), it is currently the norm in many countries. As a result, the initial recruitment criteria of co-residence with aging parents likely provides for outcome data that are more applicable to subsequent generations of adults with DS.

Despite these limitations, there are numerous strengths to the current study. Behavioural sleep disturbances were identified using clinical interviews assessing numerous questions about sleep, and detailed information was obtained from family members that knew the individual well. In addition, detailed measures of outcomes were obtained as part of a larger comprehensive study of aging in DS in order to broadly describe the associated comorbidities of sleep problems. The study also took a heterogeneous view of sleep problems, examining medical (sleep apnoea) and behavioural (sleep disturbances) sleep problems individually and their differential impact on associated comorbidities. Using this heterogeneous perspective allows for a more detailed understanding of how different sleep problems either impact or are impacted by different medical conditions and how to use sleep problems as a red flag for screening of other conditions and vice versa.

This study contributes to our understanding of sleep and its association with aging in adults with DS, a topic of importance to this aging population that has received little attention. These findings indicate that sleep is a persistent problem in aging, and associated with a host of related conditions and behavioural manifestations. Further, these findings provide a preliminary indication that the associated conditions and behavioural manifestations can differ depending on if the sleep problem is sleep apnoea or behavioural sleep disturbances, which has implications for medical and mental health screening and for treatment or interventions. Future research is needed to better understand the mechanisms responsible and the direction of the association found in the present study, and to replicate these findings.

Acknowledgments

This manuscript was prepared with support from the *Eunice Kennedy Shriver* National Institute on Child Health and Human Development (R03 HD059848, A. Esbensen, PI; P30 HD03352, M. Mailick, PI, Waisman Intellectual and Developmental Disabilities Research Center), the National Institute on Aging (R01 AG08768, M. Mailick, PI), and the Emily Ann Hayes Research Fund. I am grateful to Alison Downes for feedback on an earlier version of the manuscript, and to the blind reviewers for their supportive, encouraging and detailed feedback. This research would not have been possible without the contributions of the participating families and our project manager, Renee Makuch, to whom I am extremely grateful.

References

- Aloia MS, Illiczy N, Di Dio P, Perlis ML, Greenblatt DW, Giles DE. Neuropsychological changes and treatment compliance in older adults with sleep apnea. *Journal of psychosomatic research*. 2003; 54:71–76. [PubMed: 12505557]
- Andreou G, Galanopoulou C, Gourgoulis K, Karapetsas A, Molyvdas P. Cognitive status in Down syndrome individuals with sleep disordered breathing deficits (SDB). *Brain and Cognition*. 2002; 50:145–149. [PubMed: 12372360]
- Ashworth A, Hill CM, Karmiloff-Smith A, Dimitriou D. Cross syndrome comparison of sleep problems in children with Down syndrome and Williams syndrome. *Research in Developmental Disabilities*. 2013; 34:1572–1580. [PubMed: 23475007]
- Balkin TJ, Rupp T, Picchioni D, Wesensten NJ. Sleep loss and sleepiness: current issues. *Chest*. 2008; 134:653–60. [PubMed: 18779203]
- Beebe DW. Neurobehavioral effects of childhood sleep-disordered breathing (SDB): A comprehensive review. *Sleep*. 2006; 29:1115–1134. [PubMed: 17040000]
- Beebe DW. Cognitive, behavioral, and functional consequences of inadequate sleep in children and adolescents. *Pediatric Clinics of North America*. 2011; 58:649. [PubMed: 21600347]
- Bliwise DL. Sleep in normal aging and dementia. *Sleep: Journal of Sleep Research & Sleep Medicine*. 1993; 16:40–81.
- Boyle A, Melville CA, Morrison J, Allan L, Smiley E, Espie CA, et al. A cohort study of the prevalence of sleep problems in adults with intellectual disabilities. *Journal of Sleep Research*. 2010; 19:42–53. [PubMed: 19912512]
- Breslin J, Spanò G, Bootzin R, Anand P, Nadel L, Edgin J. Obstructive sleep apnea syndrome and cognition in Down syndrome. *Developmental Medicine and Child Neurology*. 2014; 56:657–664. [PubMed: 24471822]
- Bruininks, RH., Hill, BK., Weatherman, RF., Woodcock, RW. Inventory for client and agency planning (ICAP). Allen, TX: DLM Teaching Resources; 1986.
- Bruininks, RH., Woodcock, RW., Weatherman, RE., Hill, BK. Scales of Independent Behavior - Revised comprehensive manual. Itasca, IL: Riverside Publishing; 1996.
- Brylewski JE, Wiggs L. A questionnaire survey of sleep and night-time behaviour in a community-based sample of adults with intellectual disability. *Journal of Intellectual Disability Research*. 1998; 42:154–162. [PubMed: 9617699]

- Brylewski J, Wiggs L. Sleep problems and daytime challenging behaviour in a community-based sample of adults with intellectual disability. *Journal of Intellectual Disability Research*. 1999; 43:504–512. [PubMed: 10622367]
- Bull MJ. Committee on Genetics. Clinical report: Health supervision for children with Down syndrome. *Pediatrics*. 2011; 128:393–406. [PubMed: 21788214]
- Carter M, McCaughey E, Annaz D, Hill CM. Sleep problems in a Down syndrome population. *Archives of Diseases in Childhood*. 2009; 94:308–310. [PubMed: 18786953]
- Cohen, WI. Health care guidelines for individuals with Down syndrome—1999 revision. In: Cohen, WI, Nadel, L., Madnick, ME., editors. *Down Syndrome: Visions for the 21st Century*. New York, NY: John Wiley & Sons; 2002.
- Cooper SA, Prasher VP. Maladaptive behaviours and symptoms of dementia in adults with Down's syndrome compared with adults with intellectual disability of other aetiologies. *Journal of Intellectual Disability Research*. 1998; 42:293–300. [PubMed: 9786444]
- Cotton SM, Richdale AL. Sleep patterns and behaviour in typically developing children and children with autism, Down syndrome, Prader-Willi syndrome and intellectual disability. *Research in Autism Spectrum Disorders*. 2010; 4:490–500.
- Didden R, Sigafoos J. A review of the nature and treatment of sleep disorders in individuals with developmental disabilities. *Research in Developmental Disabilities*. 2001; 22:255–272. [PubMed: 11523951]
- Doran SM, Harvey MT, Horner RH. Sleep and developmental disabilities: assessment, treatment, and outcome measures. *Mental Retardation*. 2006; 44:13–27. [PubMed: 16405384]
- Epstein R, Pillar D, Tzichinsky O, Here P, Lavie P. Sleep disturbances in children with Downs' syndrome. *Journal of Sleep Research*, 1 Supplement. 1992; 1:68.
- Esbensen AJ. Health conditions associated with aging and end of life of adults with Down syndrome. *International Review of Research in Mental Retardation*. 2010; 39:107–126. [PubMed: 21197120]
- Esbensen AJ, Mailick MM, Silverman W. Impact of the family environment on aging in Down syndrome. *American Journal of Intellectual and Developmental Disabilities*. 2013; 118:294–309.
- Esbensen, AJ., Seltzer, MM., Krauss, MW. Life course perspectives in intellectual disability research: The case of family caregiving. In: Burack, JA, Hodapp, RM, Iarocci, G., Zigler, E., editors. *The Oxford Handbook of Intellectual Disability and Development*, Second Edition. New York, NY: Oxford Press; 2011. p. 380–391.
- Evenhuis, HM., Kengen, MMF., Eurlings, HAL. *Dementia Questionnaire for People with Learning Disabilities (DLD)*. London, UK: Harcourt Assessment; 2006.
- Fallone G, Owens JA, Deane J. Sleepiness in children and adolescents: Clinical implications. *Sleep Medicine Reviews*. 2002; 6:287–306. [PubMed: 12531133]
- Gedye, A. Manual. Vancouver, CA: Gedye Research and Consulting; 1995. *Dementia Scale for Down Syndrome*.
- Haveman M, Maaskant MA, Sturmans F. Older Dutch residents of institutions, with and without Down syndrome: Comparisons of mortality and morbidity trends and motor/social functioning. *Australia and New Zealand Journal of Developmental Disabilities*. 1989; 15:241–255.
- Idler EL, Benyamini Y. Self-rated health and mortality: A review of twenty-seven community studies. *Journal of Health and Social Behavior*. 1997; 38:21–37. [PubMed: 9097506]
- Kerins G, Petrovic K, Bruder MB, Gruman C. Medical conditions and medication use in adults with Down syndrome: A descriptive analysis. *Down Syndrome Research and Practice*. 2008; 12:141–147.
- Krauss, MW., Seltzer, MM. An unanticipated life: The impact of lifelong caregiving. In: Bersani, H., Jr, editor. *Responding to the challenge: Current trends and international issues in developmental disabilities*. Cambridge, MA: Brookline Books; 1999. p. 173–187.
- Maas APHM, Sinnema M, Didden R, Maaskant MA, Smits MG, Schrandt-Stumpel CTR, et al. Sleep disturbances and behavioural problems in adults with Prader-Willi syndrome. *Journal of Intellectual Disability Research*. 2010; 54:906–917. [PubMed: 20636465]
- Maenner MJ, Smith LE, Hong J, Makuch R, Greenberg J, Mailick MR. Evaluation of an activities of daily living scale for adolescents and adults with developmental disabilities. *Disability and Health Journal*. 2012; 6:8–17. [PubMed: 23260606]

- Malow BA, Marzec ML, McGrew SG, Wang L, Henderson LM, Stone WL. Characterizing sleep in children with autism spectrum disorders: a multidimensional approach. *Sleep*. 2006; 29:1563. [PubMed: 17252887]
- Marcus CL, Keens TG, Bautista DB, von Pechmann WS, Ward SLD. Obstructive sleep apnea in children with Down syndrome. *Pediatrics*. 1991; 88:132–139. [PubMed: 1829151]
- Marino, B., Pueschel, SM. *Heart Disease in Persons with Down Syndrome*. Baltimore: Paul H. Brooks; 1996.
- de Miguel-Díez J, Villa-Asensi JR, Álvarez-Sala J. Prevalence of sleep-disordered breathing in children with Down syndrome: Polygraphic findings in 108 children. *Sleep*. 2003; 26:1006–1009. [PubMed: 14746382]
- Montgomery P, Stores G, Wiggs L. The relative efficacy of two brief treatments for sleep problems in young learning disabled (mentally retarded) children: a randomised controlled trial. *Archives of disease in childhood*. 2004; 89:125–130. [PubMed: 14736626]
- Moss, S. *The Mini PAS-ADD Interview Pack*. Brighton, UK: Pavilion Publishing; 2002.
- Nebes RD, Buysse DJ, Halligan EM, Houck PR, Monk TH. Self-reported sleep quality predicts poor cognitive performance in healthy older adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*. 2009; 64:180–187.
- Paavonen EJ, Porkka-Heiskanen T, Lahikainen AR. Sleep quality, duration and behavioral symptoms among 5–6 year old children. *European Child and Adolescent Psychiatry*. 2009a; 18:747–754. [PubMed: 19466475]
- Paavonen EJ, Raikonen K, Lahti J, Komsu N, Heinonen K, Pesonen AK, et al. Short sleep duration and behavioral symptoms of attention-deficit/hyperactivity disorder in healthy 7- to 8-year old children. *Pediatrics*. 2009b; 123:e857–864. [PubMed: 19403479]
- Pelttari L, Rauhalta R, Polo O, Hyypä MT, Kronholm E, Viikari J, Kantola I. Upper airway obstruction in hypothyroidism. *Journal of Internal Medicine*. 1994; 236:177–181. [PubMed: 8046317]
- Prasher VP. Screening of medical problems in adults with Down syndrome. *Down Syndrome Research and Practice*. 1994; 2:59–66.
- Rajagopal KR, Abbrecht PH, Derderian SS, Pickett C, Hofeldt F, Tellis CJ, Zwillich CW. Obstructive sleep apnea in hypothyroidism. *Annals of Internal Medicine*. 1984; 101:491–494. [PubMed: 6476635]
- Resta O, Barbaro MPF, Giliberti T, Caratozzolo G, Cagnazzo MG, Scarpelli F, Nocerino MC. Sleep related breathing disorders in adults with Down syndrome. *Down Syndrome Research and Practice*. 2003; 8:115–119.
- Richdale A, Wiggs L. Behavioral Approaches to the Treatment of Sleep Problems in Children with Developmental Disorders: What Is the State of the Art? *International Journal of Behavioral Consultation and Therapy*. 2005; 1:165–190.
- Roizen NJ, Patterson D. Down's syndrome. *Lancet*. 2003; 361:1281–1289. [PubMed: 12699967]
- Rosen D, Lombardo A, Skotko B, Davidson EJ. Parental perceptions of sleep disturbances and sleep-disordered breathing in children with Down syndrome. *Clinical Pediatrics*. 2011; 50:121–125. [PubMed: 21098528]
- Saunamäki T, Jehkonen M. Depression and anxiety in obstructive sleep apnea syndrome: a review. *Acta Neurologica Scandinavica*. 2007; 116:277–288. [PubMed: 17854419]
- Seltzer MM, Krauss MW, Hong J, Orsmond GI. Continuity or discontinuity of family involvement following residential transitions of adults who have mental retardation. *Mental Retardation*. 2001; 39:181–194. [PubMed: 11419997]
- Shahar E, Whitney CW, Redline S, Lee ET, Newman AB, Nieto J, O'Connor GT, Boland LL, Schwartz JE, Samet JM. Sleep-disordered breathing and cardiovascular disease: cross-sectional results of the Sleep Heart Health Study. *American Journal of Respiratory and Critical Care Medicine*. 2001; 163:19–25. [PubMed: 11208620]
- Shott SR, Amin R, Chini B, Heubi C, Hotze S, Akers R. Obstructive Sleep Apnea: Should all children with Down syndrome be tested? *Archives of Otolaryngology Head and Neck Surgery*. 2006; 132:432–436.

- Stebbens VA, Dennis J, Samuels MP, Croft CB, Southall DP. Sleep related upper airway obstruction in a cohort with Down's syndrome. *Archives of Disease in Childhood*. 1991; 66:1333–1338. [PubMed: 1836718]
- Steenari MR, Vuontela V, Paavonen EJ, Carlson S, Fjalberg M, Aronen E. Working memory and sleep in 6- to 13- year old school children. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2003; 42:85–92. [PubMed: 12500080]
- Stores R. A preliminary study of sleep disorders and daytime behaviour problems in children with Down's syndrome. *Down Syndrome Research and Practice*. 1993; 1:29–33.
- Stores R, Stores G. Research on sleep problems and psychological function in children with Down syndrome: Implications for clinical practice and everyday care. *Down Syndrome Research and Practice*. 1996; 4:110–112.
- Stores R, Stores G, Fellows B, Buckley S. A factor analysis of sleep problems and their psychological associations in children with Down's syndrome. *Journal of Applied Research in Intellectual Disability*. 1998; 17:345–354.
- Stores, GE., Wiggs, LE. Sleep disturbance in children and adolescents with disorders of development: Its significance and management. London, UK: MacKeith Press; 2001.
- Telakivi L, Partinen M, Salmi T, Leinonen L, Härkönen T. Nocturnal periodic breathing in adults with Down's syndrome. *Journal of Mental Deficiency Research*. 1987; 31:31–39. [PubMed: 2953899]
- Trois MS, Capone GT, Lutz JA, Melendres MC, Schwartz AR, Collop NA, Marcus CL. Obstructive sleep apnea in adults with Down syndrome. *Journal of Clinical Sleep Medicine*. 2009; 15:317–323.
- Urv TK, Zigman WB, Silverman W. Psychiatric symptoms in adults with Down syndrome and Alzheimer's Disease. *American Journal on Intellectual and Developmental Disabilities*. 2010; 115:265–276. [PubMed: 20597723]
- Van Allen MI, Fung J, Jurenka SB. Health care concerns and guidelines for adults with Down syndrome. *American Journal of Medical Genetics*. 1999; 89:100–110. [PubMed: 10559765]
- Wild MR, Engleman HM, Douglas NJ, Espie CA. Can psychological factors help us to determine adherence to CPAP? A prospective study. *European Respiratory Journal*. 2004; 24:461–465. [PubMed: 15358707]
- Yang Q, Rasmussen SA, Friedman JM. Mortality associated with Down's syndrome in the USA from 1983 to 1997: A population-based study. *Lancet*. 2002; 359:1019–1025. [PubMed: 11937181]

Table 1

Demographics of adults with Down syndrome.

	Sleep Apnoea		Behavioural Sleep Disturbances	
	Yes	No	Yes	No
n	10	62	17	58
% Female	20.0%	37.1%	29.4%	36.2%
% Mild/Moderate IDD ^a	100.0%	69.4%	64.7%	77.6%
% Co-residing with family	30.0%	35.5%	17.6%	37.9%
Mean Age (SD) ^b	52.5 (5.8)	50.8 (5.8)	55.6 (4.5)	49.7 (5.7)

^a significant group difference for sleep apnoea^b significant group difference for behavioural sleep disturbances

Table 2

Means and standard deviations for adults by sleep condition on physical health, functional abilities and behaviour problems.

	Sleep Apnoea		Behavioural Sleep Disturbances	
	Yes	No	Yes	No
Health				
Current health (range 1–4) ^b	2.9 (0.7)	2.8 (0.7)	2.1 (0.7)	3.0 (0.6)
Physician visits ^a	8.2 (8.7)	4.7 (3.7)	7.7 (6.8)	4.4 (3.7)
Overnight visits ^b	0.0 (0.0)	0.2 (0.4)	0.4 (0.5)	0.1 (0.3)
Emergency department visits ^b	0.4 (0.5)	0.5 (1.1)	1.2 (1.6)	0.2 (0.6)
Functional abilities				
W-ADL (range 0–2)	1.1 (0.5)	1.0 (0.5)	0.7 (0.6)	1.1 (0.5)
Behaviour problems (range 90–150)				
Generalized ^b	102.3 (2.8)	102.4 (3.5)	104.4 (4.4)	101.7 (2.8)
Internalized	101.5 (5.0)	101.9 (5.4)	103.3 (6.7)	101.3 (4.8)
Asocial ^b	101.9 (6.5)	100.9 (6.3)	105.1 (8.9)	99.8 (4.5)
Externalized	97.5 (1.6)	97.9 (2.6)	98.0 (2.8)	97.7 (2.4)

^a significant group difference for sleep apnoea

^b significant group difference for behavioural sleep disturbances

Table 3

Percentage of adults by sleep condition and physical or mental health comorbidities

	Sleep Apnoea		Behavioural Sleep Disturbances	
	Yes	No	Yes	No
Health				
Respiratory ^a	30.0%	6.5%	11.8%	10.7%
Thyroid ^b	40.0%	43.5%	17.6%	51.8%
Cardiac ^b	20.0%	17.7%	41.2%	10.7%
Pain	40.0%	35.5%	47.1%	32.1%
Dental	60.0%	58.1%	76.5%	53.6%
Sensory	60.0%	40.3%	35.3%	46.4%
Gastrointestinal	40.0%	58.1%	52.9%	57.1%
Internal organs	0.0%	1.6%	0.0%	1.8%
Immune	0.0%	0.0%	0.0%	0.0%
Any	100.0%	91.9%	88.2%	94.6%
Mental health				
Anxiety ^b	10.0%	9.7%	23.5%	5.4%
OCD	10.0%	8.2%	17.6%	5.5%
PTSD	0.0%	4.8%	5.9%	3.6%
ADHD	0.0%	1.6%	0.0%	1.8%
Bipolar	0.0%	1.6%	0.0%	1.8%
Depression ^b	10.0%	8.1%	23.5%	3.6%
ODD	0.0%	0.0%	0.0%	0.0%
Schizophrenia	0.0%	0.0%	0.0%	0.0%
Any ^b	20.0%	24.6%	47.1%	16.4%
Dementia ^b	30.0%	24.2%	58.8%	15.5%

^a significant group difference for sleep apnoea^b significant group difference for behavioural sleep disturbances