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UNIVERSITY OF TURKU

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A FinAdo substudy

Hanni Rönnlund

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ABSTRACT

According to the Official Statistics of Finland, approximately 75% of the Finnish population become parents. At the same time, the grave impact of poor sleep on the health and wellbeing of an individual has been shown in numerous studies. Therefore, it is regrettable that studies have also shown that having a child deteriorates the sleep of the parent for a period of six years. During these six years the physical, psychological, and social development of the child is at its peak and the child needs a loving, constructive, and consistent adult to rely on.

The aim of this study was to examine the interactions of child and parental sleep and their impact on the parental perceptions of child sleep.

This study on healthy children living with their biological families and internationally adopted children was conducted as a part of the FinAdo 2 study, which is an on-going follow-up study examining the health and wellbeing of internationally adopted children in Finland. This collaboration allowed for examining the impact of genetic associations within sleep-related interactions. In addition to the 78 internationally adopted children, the study included 108 children living with their biological families, recruited from day-care facilities in Turku and Kaarina, Finland. The sleep of the children was examined by an actigraphy device, an activity sensor, during a period of one week. The parents answered on questions about socio-economic factors, and the sleep and well-being of the child and themselves. The recordings were repeated at approximately one year from the baseline for those willing to participate in the follow-up study.

The study revealed that poorly sleeping parents perceive the sleep of their children being worse than what sleep parameters in the child's actigraphy recording indicate. It also found that the poor sleep experienced by the parent does not precede child sleep problems one year later. The third finding was that parents of evening-type children, those who prefer to stay up late and wake up late in the morning, are at a higher risk of later sleep problems than parents of morning-type children, those who prefer to wake up and go to bed early. These results underline the importance of addressing poor parental sleep quality, in addition to the child's eveningness when discovering ways to help families with sleep related problems.

KEYWORDS: Child sleep, parental sleep, family, actigraphy, FinAdo

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TIIVISTELMÄ

Tilastokeskuksen tietojen mukaan noin 75 % suomalaisista saa elämänsä aikana lapsen. Samaan aikaan lukemattomat tutkimukset ovat osoittaneet vähäisen unen negatiiviset vaikutukset yksilön terveydelle ja hyvinvoinnille. Siksi onkin valitettavaa, että lapsen saannin on todettu huonontavan vanhemman unta kuuden vuoden ajaksi. Juuri näiden kuuden vuoden aikana lapsen fyysinen, psyykkinen ja sosiaalinen kehitys on nopeimmillaan ja hän tarvitsee rinnalleen rakastavan, luotettavan ja johdonmukaisen aikuisen.

Tämän tutkimuksen tarkoituksena oli selvittää lapsen ja hänen vanhempansa unen vuorovaikutusta ja sen yhteyttä vanhemman käsitykseen lapsensa unesta.

Tutkimuksessa arvioitiin terveiden, biologisissa perheissään elävien lasten ja ulkomailta Suomeen adoptoitujen lasten unta, ja se tehtiin osana ulkomailta Suomeen adoptoitujen lasten terveyttä ja hyvinvointia tutkivan FinAdo 2-tutkimuksen kanssa. Näin voitiin ottaa huomioon myös univaikeuksien perinnölliset mekanismit. Adoptoitujen 78 lasten lisäksi tutkimukseen osallistui 108 biologisissa perheissään eläviä, Turun ja Kaarinan päiväkodeista mukaan tulleita lapsia perheineen. Lasten unta rekisteröitiin viikon ajan aktigrafilla, joka on unta arvioiva aktiivisuusmittari. Lisäksi vanhemmat vastasivat omaa ja lapsensa unenlaatua ja hyvinvointia selvittäviin kyselyihin. Tutkimus toistettiin halukkaille noin vuoden kuluttua ensimmäisestä rekisteröinnistä.

Tutkimuksessa kävi ilmi, että huonosti nukkuvat vanhemmat kokevat lapsensa unen huonompana kuin se on aktigrafilla mitattuna. Lisäksi todettiin, että vanhemman huono uni ei ennusta lapsen univaikeuksia vuoden seurannassa. Kolmantena löydöksenä todettiin, että lapsen iltavirkkuus, eli taipumus herätä ja mennä nukkumaan myöhään, on yhteydessä vanhemman huonoon uneen vuoden seurannassa verrattuna aamuvirkkujen, eli varhain heräävien ja varhain nukkumaan menevien, lasten vanhempiin.

Nämä tutkimustulokset muistuttavat siitä, miten tärkeää on ottaa huomioon myös vanhemman unen laatu, ja toisaalta lapsen iltavirkkuus, kun käsitellään perheen uneen liittyviä huolia ja ongelmia.

AVAINSANAT: Lasten uni, vanhempien uni, perhe, aktigrafi, FinAdo

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Abbreviations

AASM	American Academy of Sleep Medicine
ADHD	Attention deficit hyperactivity syndrome
CCTQ	Children's ChronoType Questionnaire
DLMO	Dim-light melatonin onset
DSM-5	The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
FinAdo	Finnish adoption study
GHQ-12	Short general health questionnaire
IBD	Inflammatory bowel disease
ICD-10	International Classification of Diseases 10th Revision
ICSD-3	International classification of sleep disorders, third edition
MEQ	Morningness-Eveningness Questionnaire
MMEQ	Modified Morningness-Eveningness Questionnaire
NREM	Non-rapid eye movement
OSAS	Obstructive sleep apnoea
P	P-value
PSG	Polysomnography
REM	Rapid eye movement
SD	Standard deviation
SDSC	Sleep Disturbance Scale for Children
95% CI	95% confidence interval

List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

I Rönnlund H, Elovainio M, Virtanen I, Matomäki J, Lapinleimu H. Poor Parental Sleep and the Reported Sleep Quality of Their Children. *Pediatrics*. 2016;137 (4):e20153425. doi: 10.1542/peds.2015-3425. Epub 2016 Mar 24. PMID: 27012745.

II Rönnlund H, Elovainio M, Virtanen I, Heikkilä AR, Raaska H, Lapinleimu H. Poor parental sleep did not predict future sleep problems in children aged 2-6 years. *Acta Paediatr*. 2021; 110 (11):3094-3096. doi: 10.1111/apa.15984. Epub 2021 Jun 28. PMID: 34129739.

III Rönnlund H, Elovainio M, Virtanen I, Heikkilä AR, Raaska H, Lapinleimu H. Child Eveningness as a Predictor of Parental Sleep. *Children*. 2022; 9(12):1968. https://doi.org/10.3390/children9121968

1 Introduction

The average need for sleep varies depending on a person's age. For adults the recommendation is at least seven hours of sleep per day (Watson et al., 2015) and for three- to five-year-olds the recommended amount is 10-13 hours of sleep per day, including naps. (Paruthi et al., 2016) Consequently, roughly a third of an individual's life is spent asleep. Having this as a backdrop, the vast consequences of poor sleep do not come as a surprise. (Riemann et al., 2015) In adults, poor sleep has been linked to numerous consequences on health, ranging from motor vehicle accidents, (Tefft, 2018) dementia (Irwin & Vitiello, 2019) to acute myocardial infarction. (Laugsand et al., 2011) In children, this wide array of consequences includes conductive disorders and depression, (Gregory et al., 2009) and poor school performance (Stormark et al., 2019) among others.

A complex array of intrinsic and extrinsic factors impacts a person's sleep cycle and the probability of falling and staying asleep. Two major actors in this setting are the sleep/wake homeostasis, also called process S, and the intrinsic circadian clock, process C. (Borbely, 1982) The sleep/wake homeostasis, process S, is maintained by sleep pressure, which begins to build up slowly after a person wakes up from sleep. The longer the person is awake, the larger the sleep pressure becomes, making the person sleepier and sleepier, until the person goes to sleep and the sleep pressure declines to a level depending on the length of the sleep. Simultaneously, the circadian clock sustains a person's diurnal rhythm leading often to a consistent sleep pattern. It regulates the ease or probability of falling asleep in a way that usually results in difficulties of falling asleep at four p.m. and staying awake at four a.m. These two systems coordinate sleep-wake cycles of a person so that in most cases the longest sleep periods occur during the night.

The probability of falling asleep at a certain time point is consequently determined by the sleep pressure and the time of the day. However, many other factors also impact the ease of falling asleep and staying asleep. These include both physiological, psychological, social, and environmental aspects (Figure 1).

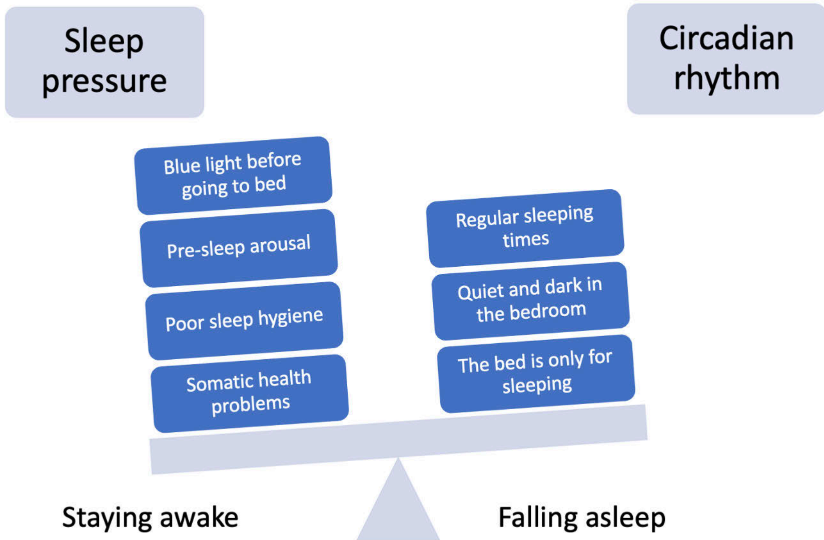

Figure 1. The homeostasis between sleep pressure and the circadian rhythm is influenced by many sleep enhancing and hindering factors.

Although approximately 75% of the Finnish population become parents, (Official Statistics of Finland (OSF), 2020) the sleep of parents per se and the interaction between the sleep of the child and the parent has only quite recently established a niche interest in the academic research. The need for this research indeed exists as in addition to the large group of people that are affected by these interactions, (Official Statistics of Finland, 2020) the grave impact of having a child on the sleep of the parent is also evident. According to one US study, having a child leads in total to a deficit of 645 hours of sleep for the parent. (Hagen et al., 2013)

Previous research has shown that the impact of having a child on the sleep of the parent is further influenced by child-related factors, such as child sleep problems, (Boergers et al., 2007) child illnesses (Meltzer & Mindell, 2006) and disabilities. (Gallagher et al., 2010; Hartman et al., 2022) However, many aspects of the interactions between parents and their child's sleep are still undiscovered. For instance, it is not known whether the timing of a child's sleep, i.e. the child being an early riser, colloquially a lark, or going late to bed, called an owl, has implications on parental sleep. Further, it is unclear if and how poor parental sleep impacts the sleep of the pre-school child.

The decline in sleep after becoming a parent is probably largely explained by the high prevalence of child sleep problems: Almost half of preschool children experience some kind of trouble with their sleep at least three times a week. (Simola et al., 2010) As children often require parental assistance to soothe themselves back into sleep, the impact of a child's sleeping troubles on parental sleep quality is obvious. It is of note that the sleeping problems of children are mainly diagnosed based on parental reports. (Rintahaka, 2021) Whether the poor parental sleep quality that child sleeping problems may induce impacts the parental reports of the child's sleep is also unknown.

To improve the health and quality of life of this large part of the population, this study sought to explore the interactions of child and family sleep. As many characteristics of a person's sleep are partially heritable, (Riemann et al., 2015) the study population of this dissertation was chosen to also include internationally adopted children, allowing for the consideration of these heritable aspects.

This doctoral thesis will present aspects of parental and child sleep focusing on poor parental sleep quality, sleep problems of preschool children and different ways child and parental sleep interact. Specifically, the aim was to discover whether poor parental sleep impacts the parent's perception of the sleep of their child. Further the dissertation aimed to study whether poor parental sleep predicts the sleep problems of the child, and if parental sleep is impacted by the chronotype of the child, i.e. the child being an early riser or going late to bed.

2 Review of the Literature

2.1 Why do we sleep?

The reason to why we sleep is still not quite clear. At the moment, the most plausible explanation for the need to sleep is the need for the brain's glymphatic system to function in order to eradicate metabolic waste, including beta-amyloid. (Jessen et al., 2015) Unlike the rest of the body, where the lymphatic system functions parallel to blood vessels in transferring nutrients to and metabolites from tissues, the central nervous system lacks lymphatic vessels. Relatively recently however, a similar system to lymphatic vessels has been found in the central nervous system, namely the glymphatic system. Its vessels surround the brain and spinal tissues, act as sewage canals, and possibly also provide tissues with nutrients. (Jessen et al., 2015) A characteristic of the glymphatic system is, that it seems to function most efficiently during sleep. This could explain why sleep loss has been associated with a variety of cognitive changes and pathologies. (Mason et al., 2021; Riemann et al., 2015)

2.2 The development of sleep during the life span

The circadian clock of a new-born is still immature and the sleep phases are scattered throughout the 24 hours. After the first three months, babies tend to sleep their longest continuous periods during the night and begin to stay alert for longer periods of time during the day. (Henderson et al., 2010) The quality and quantity of sleep between infants vary considerably during the first two years of life. (Paavonen et al., 2020) The sleep cycles of an infant are short, 50-60 minutes, and the sleep consists of immature sleep stages, called stage N and stage R. During childhood a child's sleep structure will begin to resemble that of an adult, with a sleep cycle of 90-100 minutes and alternating periods of non-rapid-eye-movement (NREM) sleep and rapid-eye-movement (REM) sleep. (Malhotra & Avidan, 2014)

The total sleep time declines during childhood. According to a large national study by Paavonen et al., a Finnish three-month-old baby sleeps on average 14.4 hours a day (range 6-20.5 hours). (Paavonen et al., 2020) During the infancy and toddlerhood the total sleep amount declines and at two-years-of age is approximately

12 hours (range 8.3-14.5 hours), (Paavonen et al., 2020) at five years roughly ten hours (range approximately 8-12 hours), and at 11 years a little under 10 hours (range approximately 8-11 hours). (Finnish Institute for Health and Welfare, 2021) These amounts concur with the findings of international studies: In 2012, an international meta-analysis of normative sleep amounts and their development found that the total amount of sleep time for infants ranged between 9.7-15.9 hours and that of toddlers and pre-school children varied between 9.9-13.8 hours. (Galland et al., 2012) The same study discovered that the amount of sleep varies according to location and culture: the sleep amounts in predominantly Asian studies were one hour shorter than in studies made in Caucasian/non-Asian settings. (Galland et al., 2012) This observation was also made in a study including 30,000 infants and toddlers from different continents. (Mindell et al., 2010)

It is important to notice that these values on the average amount of sleep derived from community-dwelling individuals may not always express the recommended or desirable amounts of sleep. (Baroni & Bruni, 2018) Differences in the required and actual sleep durations can be seen in children as young as two years old. (Zimmermann, 2016)

The American Academy of Sleep Medicine (AASM) recommends a total amount of sleep of 12-16 hours for infants at 4-12 months, 11-14 hours for toddlers between the ages of one and two years, and a total sleep time of 10-13 hours for children of the age three to five years. These recommended amounts include eventual daytime naps. (Paruthi et al., 2016)

The amount and length of naps also vary from child to child. (Lokhandwala & Spencer, 2022) According to some literature, the physiological need for naps ceases at approximately two years of age. (Marcdante et al., 2023) However, epidemiological studies indicate that the cessation of napping is also culturally and racially steered: a study on children in Mississippi, US, found that almost 40% of black children napped regularly at age 8, whereas only 5% of their white peers napped at the same age. Of Japanese children 46% nap at the age of 4.5 years. (Ikeda et al., 2012) By two-years of age, when some literature indicates the physiological need for naps ends, 97% of Finnish children still nap. (Paavonen et al., 2020a) Studies on the age when Finnish children cease to nap are lacking but the general idea is that napping ends at the age of 3-5 years. (Rintahaka, 2021)

During the school years, the amount of sleep slowly declines. For six- to twelve-years-old children, the AASM recommends a total amount of sleep of 9-12 hours. (Paruthi et al., 2016) Often in adolescence the total sleep amount declines further and symptoms of a sleep deficit become more pronounced (Crowley et al., 2007; Leger et al., 2012; Saarenpää-Heikkilä et al., 1995). This is thought to result from the slower accumulation of sleep pressure in adolescence compared to pre-adolescence, (Jenni et al., 2005) which leads to later bed times while school start times stay the same or become earlier (Clara & Allen Gomes, 2020) and the need for sleep seems to stay the same. (Short et al., 2018) Interestingly, theories have also been proposed, that the daytime sleepiness that is prevalent in adolescents might also be caused by the adolescent brain developing and reorganising its neural structures. (Campbell et al., 2017)

The timing of adolescent sleep shifts towards staying up in the evening and leading to difficulties of waking up for school becoming more common than in younger school children. (Crowley et al., 2007) It seems that the body mass index, race, and income also impact sleep variables of adolescents: According to an actigraphy study on 4,000 adolescents in the United States, black youth and youth from low-income families slept considerably less than their white peers or adolescents from high-income families. (Giddens et al., 2022)

The Finnish population meets the sleep recommendations fairly well: An international study on adolescent sleep discovered that Finnish adolescents sleep on the average 8 hours and 24 minutes on school days and 9 hours and 44 minutes on days off. Their wake-up times and bedtimes are on school days 7:00 and 22:30 and on non-school days 10:00 and 24:00. (Gariepy et al., 2020) This is close to the AASM recommendation for the amount of sleep of 13- to 18-year-olds, which is eight to ten hours of sleep a day. (Paruthi et al., 2016)

Moreover, in the adult population, the recommendations are met in an adequate degree: according to the Finnish FINRISKI 2012 study on nearly 6000 adults in 2012, 87.4% of Finnish 25- to 74-year-olds slept over seven hours a day, (Borodulin et al., 2013) which is the minimum recommendation for adult daily sleep. (Watson et al., 2015) These figures are very satisfactory compared to those of the United States in 2014 when only 65.2% met the recommendation. (Liu et al., 2019) Further, during the last decades the sleep duration of adults has more or less stayed the same. (Ford et al., 2015; Youngstedt et al., 2016)

As people grow older, the sleep of older adults often shifts to earlier in the night and the sleep becomes more disrupted. (Taillard et al., 2021) Additionally, many medical disorders and medications that impact sleep parameters become more prevalent with age (Quan & Zee, 2004) impacting the sleep quality of the elderly.

2.3 Clinical sleep disturbances and sleep related symptoms

Sleep disturbances include a variety of problems concerning falling asleep, staying asleep and the quality of sleep. Characteristic for these problems is the high sporadic prevalence of symptoms that do not fulfil the diagnostic criteria of a disorder but belong to the normal variation of sleep quality. For instance, 45% of the Finnish adult population seems to have occasional insomnia-related symptoms, but the incidence of chronic insomnia is only 9%. (Kronholm et al., 2016)

In addition, having some kind of sleep problem is quite common in preschool children: According to a Finnish study from 2011, 49% of parents of 3- to 6-year-old children reported their child as having some kind of a problem (including e.g. refusal to go to bed, sleep hyperhidrosis, sleep talking, and bruxism) with their sleep at least three nights a week. For school aged children, this amount was 31%. (Simola et al., 2012)

2.3.1 Classification of sleep disorders

The International Classification of Sleep Disorders, version 3 (ICSD-3) divides sleep disorders into seven categories, each mentioning the related isolated symptoms and normal variants. (American Academy of Sleep Medicine, 2014) These seven categories are insomnia, sleep related breathing disorders, central disorders of hypersomnolence, circadian rhythm sleep-wake disorders, parasomnias, sleep related movement disorders, and other sleep disorders, see Table 1. In the two international classifications of diseases, International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) (World Health Organization, 2019) and the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5), (American Psychiatric Association, 2013) sleep disturbances are divided in a different manner. In the former, the disorders are classified under three different sub categorises: G47 sleep disorders, F51 nonorganic sleep disorders, and restless legs under G25 other extrapyramidal and movements disorders. The approach of the DSM-5 is more comprehensive classifying all sleep related disorders into one group. See Table 1.

Table 1. Classification of different sleep disorders according to ICSD-3, ICD-10 and DSM-5.

ICSD-3	ICD-10	DSM-5
INSOMNIA	G47.0 Disorders of initiating and maintaining sleep [insomnias]	Insomnia disorder
SLEEP RELATED BREATHING DISORDERS	G47.3 Sleep apnoea	Breathing-related sleep disorders
CENTRAL DISORDERS OF EXCESSIVE SOMNOLENCE	G47.1 Disorders of excessive somnolence [hypersomnias]	Hypersomnolence disorder
	G47.4 Narcolepsy and cataplexy	Narcolepsy
CIRCADIAN RHYTHM SLEEP-WAKE DISORDERS	G47.2 Disorders of the sleep-wake schedule	Circadian rhythm sleep disorders
	F51.2 Nonorganic disorder of the sleep-wake schedule	
PARASOMNIAS	F51.3 Sleep walking	Non-REM (NREM) sleep arousal disorders
	F51.4 Sleep terrors	
	F51.5 Nightmares	Nightmare disorder
		REM sleep behaviour disorder
SLEEP RELATED MOVEMENT DISORDERS	G25.81 Restless legs syndrome	Restless legs syndrome
OTHER SLEEP DISORDERS	Other sleep disorders	Substance- or medication-induced sleep disorder
	Unclassified sleep disorders	

2.3.2 Insomnia

The ICSD-3 category of insomnia includes chronic insomnia, short-term insomnia and other insomnia. Excessive time in bed is mentioned as an isolated symptom and short sleeper as a normal variant. These may display as insomnia although they are something completely different in character: An overestimation of the sleep need of a child can lead to an excessive time in bed and the child having difficulties falling asleep and staying asleep. However, these problems disappear when bedtimes are adjusted to the child's needs.

As the child grows, their sleep evolves and becomes more continuous. The developing of self-soothing skills allows for falling asleep independently if the child wakes up during the night.

Normative sleep development includes night-wakings during the infant and toddler years, (Paavonen et al., 2020) which parents seem to be aware of: According to an Australian study, during the infant period 17.1% of caregivers reported child sleep problems and the percentage of these complaints declined to 7.7% at 10-11 years. (Williamson et al., 2019) See Figure 2. However, the prevalence of different sleep behaviours in children was higher than that of the complaints. In infancy, 40.8% of parents reported their baby waking during the night, around 10% of parents reported that the baby was not happy to sleep alone and another 10% of troubles getting to sleep. At 4- to 5-years of age the incidence of waking during the night declined to above 15%, trouble getting to sleep stayed around 10%, however, the number of children not wanting to sleep alone doubled. At 10-11 years 90% of children were again happy to sleep alone and waking during the night also declined to a level of 5%. However, at this age, troubles of getting to sleep had increased steadily to 17.6%.

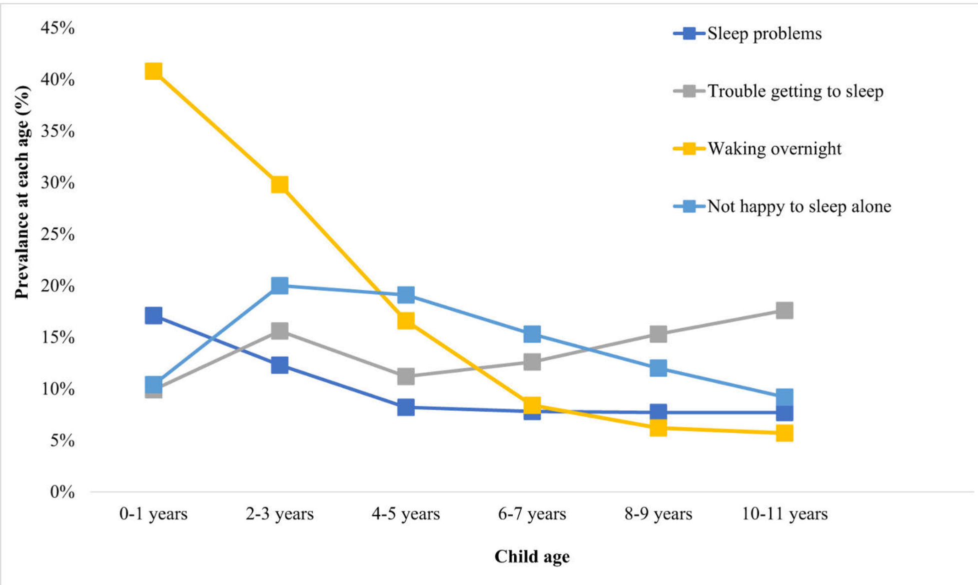

Figure 2. Prevalence of sleep problems and different sleep behaviours, here trouble getting to sleep, waking during the night and not happy to sleep alone, from infancy to school age according to Williamson et al. 2019. Reprinted from Sleep Medicine, Vol. 63, Williamson A, Mindell J, Hiscock H, Quach J, Child sleep behaviors and sleep problems from infancy to school age, p.5-8, Copyright 2019, with permission from Elsevier.

This finding is in line with epidemiological studies on children's insomnia disorder where the onset of symptoms is usually around 11 years of age (Johnson et al., 2006) Female gender is a risk factor for insomnia (Buysse, 2013; Riemann et al., 2015) and its effect emerges during puberty: the beginning of menses raises the risk of insomnia to over two-fold compared to boys, regardless of the boy's maturational status. (Johnson et al., 2006)

According to follow up studies, insomnia and difficulties of initiating and maintaining sleep are quite persistent. Of those children with some kind of a sleep problem at school age, 84% were reported as already having a problem at preschool age. (Simola et al., 2012) Similarly, of the nine-year-old children with difficulties of initiating or maintaining sleep, 43% still experienced difficulties at the age of 24. (Fernandez-Mendoza et al., 2022) Correspondingly, of the nine-year-old children without sleep problems, 48% did not experience later sleep problems during the follow-up. Sleep problems and insomnia seem persistent through young adulthood (Buysse et al., 2008) and the rest of life. (Morin et al., 2009; Riemann et al., 2015)

In the FINRISKI 2012 study, 10% of participants answered that they had been suffering from insomnia often during the last month. (Borodulin et al., 2013; Kronholm et al., 2016) In all participants, aged between 25-74 years, the percentage was higher for females than males, 11.9% vs. 7.7% respectively. (Borodulin et al., 2013) The reports on experiences of insomnia symptoms were often highest in the 55-65-year-old group (females 17.0% and males 11.7%), declining slightly to 14.8% in 65-74-year-old females and 7.4% in males of the same age group.

The predisposition for insomnia seems partly genetic: different reviews have estimated the impact of genes at approximately 50%. (Madrid-Valero & Gregory, 2023; Riemann et al., 2015)

2.3.3 Sleep-related breathing disorders

The ICSD-3 category of sleep related breathing disorders includes obstructive sleep apnoea disorders (OSAS), central sleep apnoea syndromes, sleep related hypoventilation disorders, and sleep related hypoxemia disorders.

The most frequent sleep breathing disorder is OSAS. Its prevalence is around 2% for children aged three months to eight years. (Gulotta et al., 2019; Katila et al., 2021) The prevalence declines during the school years due to the growing upper airways but during adulthood the risk for OSAS increases again, (Gulotta et al., 2019; Marcus et al., 2012; Tan et al., 2013) with Finnish estimates of a prevalence of 3.7% (Palomäki et al., 2022) and international prevalence estimates ranging between 9 and 38% depending on the diagnostic criteria. The reasons for OSAS in children deviate to a degree to those of the adults: Increasingly, overweight has become a cause of OSAS in children as well as in adults, (Gulotta et al., 2019; Lee & Sundar, 2021) but for children the lead cause is still hypertrophy of the adenoids. (Gulotta et al., 2019)

2.3.4 Hypersomnolence

Central disorders of hypersomnolence include e.g. narcolepsies type 1 and 2, and idiopathic hypersomnia. Narcolepsy, which forms its own entity in both ICD-10 and DSM-5, is a condition where the person has difficulties maintaining wakefulness. Somnolence starts to build up at any time of the day and may lead to a compulsive need to fall asleep, which can occur even during talking. (Barateau et al., 2022) A patognomic symptom of type 1 narcolepsy is cataplexy involving the loss of muscle tone triggered by strong, often positive, emotions. (Barateau et al., 2022) Narcolepsies are rare conditions with a prevalence for narcolepsy 1 of approximately 17-26 cases per 100 000 persons. (Hublin et al., 1994; Kallweit et al., 2022) Their prevalence peak at two different time points: around 15 and 35 years of age, (Dauvilliers et al., 2001) but the lag of diagnosis after symptom onset may be up to 10 years. (Maski & Owens, 2016)

A normal variant of hypersomnolence is being a long sleeper and exceeding the average need for sleep. Here, after an adequate amount of sleep, the person feels well-rested as opposed to the central disorders of somnolence, where sleep alleviates tiredness only to a degree or for a shorter amount of time.

Further, on a population level, hypersomnolence is most often caused by insufficient sleep due to too short sleep. This is to be differentiated from clinical central disorders of hypersomnolence. Once opportunities for sleeping are arranged to meet the need for sleep, tiredness disperses. However, the notion from the clinical context is that in children sleep deprivation rarely exhibits itself as somnolence but rather as restlessness, symptoms of conduct disorder, and difficulties of emotional regulation.

It is also of note that questionnaires enquiring about different sleep problems (Bruni et al., 1996) may include a sub score of excessive somnolence, which includes symptoms of sleepiness during the day arising for instance from a short sleep time, and not only central disorders of hypersomnolence.

Additionally, chronic fatigue syndrome, also known as myalgic encephalomyelitis, is not classified as a sleep disturbance even though its lead symptoms may be extreme tiredness. The causes of the syndrome are various and the pathophysiology is still unknown. (Mohamed et al., 2023)

2.3.5 Circadian rhythm disorders

Circadian rhythm disorders include disturbances of the diurnal rhythm, where the individual has difficulties in maintaining a distribution of sleep and wake during a 24-hour period that enables being a full member of society. These may originate in intrinsic disturbances or habitual problems of maintaining a consistent daily pattern.

These disorders are divided into delayed sleep-wake phase disorder, advanced sleep-wake phase disorder, non-24-hour sleep-wake rhythm disorder, and irregular sleep-wake rhythm disorder. (Auger et al., 2015) In the delayed sleep-wake phase disorder, affecting 3.3% of adolescents and young adults, (Sivertsen et al., 2013, 2021) and advanced sleep-wake phase disorders, affecting 0.04% of the population, (Curtis et al., 2019) the phase of the person's sleep-wake cycle does not coincide with that of the surrounding society. Depending on the degree of the disorder, someone with advanced sleep-wake disorder may go to bed at 8 p.m. and wake up at 4 a.m. and have difficulties staying awake longer in the evening. Similarly in delayed sleep wake phase disorder, a person may go to bed at 4 a.m. and wake up at 12 p.m. The prevalence of advanced sleep phase disorder seems to increase with age. (Paine et al., 2014) In contrast, the delayed sleep phase disorder peaks during adolescence and young adulthood and declines from then onwards. (Paine et al., 2014) According to one study, the incidence of the delayed phase disorder in bipolar depressed adolescent patients was as high as 62% and in adolescents with unipolar depression 30%. (Robillard et al., 2013)

Without meeting the criteria for delayed sleep-wake phase disorder, delay in the diurnal rhythm is common and can be evidenced in children as young as four years old. (Jafar et al., 2017) This aspect is discussed in more detail later.

Visible light is one of the major environmental cues that entrain the diurnal rhythm, also called Zeitgebers. Thus unsurprisingly, the non-24-hour sleep-wake rhythm disorder is more prevalent in totally blind people. For these patients, the length of the intrinsic day deviates from 24 hours, often producing longer circadian durations. Conversely, patients with irregular sleep-wake rhythm disorder often have neurodevelopmental, neurodegenerative or psychiatric disorders.

2.3.6 Parasomnias, sleep talking and sleep related movement disorders

In ICSD-3, all parasomnias have been classified under one category, deviating from both ICD-10 and DSM-5, where they have been either classified into smaller categories as in ICD-10, or by their pathophysiology into non-REM sleep arousal disorders, REM sleep behaviour disorders, and nightmare disorders as in DSM-5. This ICSD-3 category includes e.g. the NREM sleep-related parasomnias of confusional arousals, sleep walking, and sleep terrors; the REM sleep-related parasomnias such as nightmare disorders, and other parasomnias such as sleep enuresis. Due to the high lifetime prevalence of sleep talking, which is up to 67%, (Bjorvatn et al., 2010) ICSD-3 categorises this as a normal variant. Recently, diagnostic criteria for a restless sleep disorder have been developed. (DelRosso et al., 2020) The disorder includes restless sleep containing large body movements during sleep, these are evidenced in video-polysomnography, and impair daytime function.

In ICD-10 and DSM-5, restless legs syndrome has its own category but in ICSD-3 it has been classified under sleep related movement disorders, which also include disorders as such as bruxism (biting teeth together in sleep) or periodic limb movement disorder. Other sleep related movement disorders that typically manifest in children are head banging or body rocking while falling asleep and continuing into light sleep.

In addition, hypnic jerks emerge at the time of sleep onset. They appear as twitching of the limbs and are also known as sleep jerks, or sleep twitching. Hypnagogic hallucinations appear also when falling asleep. They include visual, auditory or sensory hallucinations.

The prevalence of parasomnias in preschool children is high. According to a follow-up study made in 2007 on children from the age of two to six years, over 85% of the children experienced some kind of parasomnia during the follow-up period. (Petit et al., 2007) At that time sleep talking still was considered a parasomnia, and it was also the most common form affecting 85% of the children at some point. Sleep terrors, sleep talking, and rhythmic movements had an onset at an early age, with incidences declining during the follow-up. Sleep bruxism was quite persistent, with onset numbers which were steady throughout the study period and an overall prevalence of 45% during the study period. A longer follow-up study by the researchers found that the prevalence of sleep walking increased during early school age, reaching a peak of 13% at 10 years of age. (Petit et al., 2015)

In youth and adults, the prevalence of parasomnias is much lower. In a study on 5000 British individuals, the prevalence of night terrors was 2.2%, that of sleep walking 2.0% and confusional arousals 4.2%. The prevalence numbers all declined from the age 15 to over 64-year-olds. (Ohayon & Priest, 1999)

2.4 Sleeping problems of children

2.4.1 Factors impacting child sleep

As with adults, many factors, both intrinsic and extrinsic, impact the timing and quality of children’s sleep. Parental well-being and socioeconomic aspects have been shown to associate with child sleep quality. (Lupini et al., 2022; Meltzer et al., 2021; Meltzer & Montgomery-Downs, 2011; Pine et al., 2022)

Sleep within the family is a dynamic process and naturally the environment where the child spends their time impacts the sleep of the child. (Meltzer & Montgomery-Downs, 2011; Sadeh et al., 2010) Parental hostility towards each other (Rhoades et al., 2012) and marital instability (Mannering et al., 2011) have been shown to be associated with child sleep problems in follow-ups. In addition, caregiver depression, (Pine et al., 2022; Williamson & Mindell, 2020) lower caregiver education, having a single care giver and a crowded home have been shown to increase the risk of child sleep problems. (Lupini et al., 2022)

On the other hand, parental warmth and time spent on meals have been shown to predict more hours of weekday sleep. (Adam et al., 2007) Parental knowledge of the age-appropriate amount of sleep and sleep enhancing practices has been shown to associate with earlier bedtimes and more consistent sleep schedules and bedtime routines. (McDowall et al., 2017) Correspondingly, the poor sleep hygiene of the parent themselves has been shown to associate with the poor sleep hygiene of the child and child sleep problems. (Chehri et al., 2022)

Parental practices at the time of sleep onset and at night have been shown to have implications on child sleep quality as well: Parental presence until sleep onset (Touchette et al., 2005) and interactions during the night has also been linked to poorer sleep quality of children and especially a slower development of self-soothing skills during infancy and toddlerhood. (Sadeh et al., 2009) Moreover, low parental tolerance of crying has been associated with infant sleep problems. (Sadeh et al., 2016)

Parental actions play an important role in setting bedtimes and ensuring sleep enhancing surroundings as a way of life. Consistent sleep times and sleep time routines have been shown to improve child sleep. (Hoyniak et al., 2020; Mindell et al., 2015) Accordingly, in a meta-analysis of 45 trials, interventions including earlier bedtimes of the child, resulted in a 47 minute longer sleep duration in school children and adolescents. (Magee et al., 2022) Furthermore, ensuring healthy choices may also be associated with sleep quality: soda and fast-food consumption and lack of fruit and vegetables in the diet is associated with shorter sleep duration. (Armstrong et al., 2014; Holmes et al., 2021)

Further, many studies have shown the worsening impact of digital media on the sleep of children. (Kahn et al., 2021; LeBourgeois et al., 2017; Xu et al., 2016) This impact is probably caused by the time spent away from play and other sleep enhancing activities and partly by the blue light the devices emit, which when received before bedtime, prolongs sleep onset, and diminishes sleep quality. (LeBourgeois et al., 2017; Xu et al., 2016) In a study conducted in 2011, even the simple existence of a TV in the child's bedroom seemed to decrease the amount of sleep. (Garrison et al., 2011) The same finding was later replicated in a study using actigraphy. (Helm & Spencer, 2019) In addition, the use of a smart phone has been shown to associate with a decrease in total sleep time and an increase in nocturnal awakenings in children. (Kim et al., 2020) Thus, setting limits on digital media use is one way to enhance child sleep and well-being.

However, some aspects regarding sleep are beyond parental control: Sleep problems seem partially genetic and estimates of hereditability vary between 15-40%. (Barclay et al., 2015; Genderson et al., 2013; Gregory et al., 2009; Lind et al., 2015) Additionally, being born preterm (Brockmann et al., 2020) may decrease sleep quality well into the school age, and chronic conditions such as atopic dermatitis, (Chang et al., 2014) and epilepsy (Zambrelli et al., 2020) have been shown to deteriorate sleep. Symptoms of attention deficit hyperactivity disorder, (ADHD) especially if not medicated, seem to also decrease sleep quality. (Bar et al., 2016)

Moreover, studies have shown that a child's chronotype, which is simply a matter of whether the child prefers to go to sleep early or late in the evening, impacts the risk of sleeping problems; evening type children, those who prefer to go to bed late and sleep longer in the morning, are at a higher risk for sleep problems. (Eid et al., 2020) The impact of chronotype on sleep and well-being is discussed more thoroughly in Chapter 2.7.2. In addition, the availability of light, and thereby the changing of the seasons at higher latitudes, impacts the sleep of a person. (Elovainio et al., 2022; Kärki et al., 2020; Stothard et al., 2017)

2.4.2 Impact of sleep problems on the well-being of the child

Due to the all-encompassing effect of poor sleep on a person, the impact of child sleep problems has been thoroughly studied and the findings have been gathered in many reviews, see e.g. Chaput et al., 2017, Reynaud et al., 2018, and Spruyt, 2019. Drawing from these reviews and meta-analyses poor sleep in children and adolescents seems to associate with overweight, difficulties in problem solving, reasoning and executive functioning, in addition to problems with behavioural and emotional development. In the review by Chaput et al., 2017, short sleep durations in 0-4-year-olds were further associated with impaired growth and higher risk of injuries.

Moreover, studies specifically on the psychological consequences of poor child sleep have found child sleep problems to be associated with a variety of outcomes. In a systematic review of 26 studies, poor sleep in early childhood, i.e. 0-8 year-olds, was associated with anxiety, depression and ADHD in adolescence. (Lam & Lam, 2021) In other studies, the negative impact of poor sleep has also been documented as affecting academic achievement, (Diaz et al., 2017; Stormark et al., 2019) and student-teacher conflict in young school children. (Holdaway & Becker, 2018)

These associations may be diminished with appropriate treatment. Namely, in a study of internet-based treatment of child sleep problems, not only did the children's sleep and caregiver mental health improve during the intervention, but the health service use associated with child sleep also declined. (Hiscock et al., 2021)

2.5 Child sleep in the context of family

2.5.1 The impact of having a child and child sleep problems on parental sleep

It is a well-known fact that having a child deteriorates the sleep of the parent. Research has indicated that parental sleep duration and satisfaction decline after having a child and does not start to approach the baseline again until the child turns six years old. (Richter et al., 2019) An American study quantified this deterioration to a total amount of 645 hours sleep lost per child. (Hagen et al., 2013) The younger the child, the larger the sleep loss: having a child under two-years old equated to 13 minutes of sleep loss per day. Parents of children aged between 2-5 years slept 9 minutes less than the controls and parents of children and youth aged between 6 and 18 years had a total sleep time 4 minutes shorter than those without children. (Hagen et al., 2013)

In addition to the impact of having a child on the sleep of a person, many aspects affect the degree to which the parental sleep deteriorates. A child needs care and assistance in varying amounts throughout their development and the troubles and hardships of the child impact the parents to a high degree. Consistently, the sleep of parents of children with disabilities is poorer both subjectively (Gallagher et al., 2010) and objectively (Hartman et al., 2022) compared to parents of children without disabilities even when the sleep disruptions caused by the child were accounted for. Moreover, with children with sleeping problems the degree of problems seems to affect the extent they impact parental sleep: parents of children with more than one type of sleeping disorder experience more daytime tiredness than parents of children with only one kind of sleeping disorder. (Boergers et al., 2007)

Qualitative research has described the feelings of mothers with children who sleep poorly; the mothers expressed emotions of resignation, guilt or shame, confusion or frustration, and defeat. (Smith et al., 2019) Putting a reluctant child to bed or anticipating a night with many awakenings, causes negative feelings, (Smith et al., 2019) These may lead to a state of alertness due to trying to comprehend how the situation can be alleviated, which at the time of sleep onset has been called pre-sleep cognitive arousal. This arousal has been shown to worsen sleep quality (Bean et al., 2021; Wuyts et al., 2012) and may partly explain, naturally in addition to the disruptions of night-time sleep, why parents of children with sleep disturbances sleep more poorly than those of children who sleep well. (Boergers et al., 2007; Meltzer & Mindell, 2007)

Additionally, children’s sleep problems, especially bedtime resistance and daytime somnolence, have been shown to increase parenting stress (Byars et al.,

2011) which is linked with a longer sleep onset delay and poorer sleep quality. (McQuillan et al., 2019)

Nonetheless, regardless of parental mood or pre-sleep arousal, it seems that the most important factor impacting parental sleep is the sleep quality of the child. (Varma et al., 2018) The impact of child sleep problems has been shown objectively to associate with a greater variability in both parental and child bedtimes and more wake periods after sleep onset. (Varma et al., 2022)

2.5.2 Maternal vs. paternal sleep

The vast majority of child sleep studies have researched sleep from the viewpoint of the child or the child-mother dyad. (Meltzer & Montgomery-Downs, 2011) Lately, as a trend towards more equal parental responsibilities between the parents has gained strength, (Goldscheider et al., 2014) the academic community has become aware of the role of the father in different aspects, including sleep, of child health. (Coles et al., 2021; Meltzer & Montgomery-Downs, 2011) Studies on families with same-sex parents are still scarce.

As the main body of research has been carried out on mothers, a Swedish study sought out to uncover whether dual working, opposite-sex parents share the night-time involvement in the child's sleeping problems equally. (Härdelin et al., 2021) Maybe surprisingly, the study found out that the parental sleep, objectively measured, was similar, but the mothers more often experienced the sleep insufficient than fathers. The limitations of the study included the fact that Sweden, and the Nordic countries, are forerunners in equality between sexes and the paternal involvement in childcare is high in these countries, (Eydal et al., 2015) which may hinder the generalization of the results. However, an Australian study on children with sleeping disorders also found that mothers experienced more somnolence than fathers even though their sleep durations were equivalent. (Boergers et al., 2007) The Swedish study group hypothesized that this finding arose from women in general sleeping longer and having a larger subjective need for sleep. (Mallampalli & Carter, 2014; Polo-Kantola et al., 2016)

Nevertheless, the differing degree to which the child's sleep impacts the sleep of mothers and fathers may be impacted by culture. In international studies, contrary findings have also been published. In an actigraphy study by Kouros et al. on children and parents from Alabama, United States, the maternal sleep quality and duration was associated with both the child and the paternal sleep parameters. (Kouros & El-Sheikh, 2017) The paternal sleep however, was only associated with maternal sleep. Further, a German questionnaire-based study found that for mothers, child sleep quality impacted the partner relationship satisfaction through the changes in maternal sleep quality and quantity. For fathers, child sleep quality impacted only the paternal sleep amount but not the satisfaction with the relationship with their partner. (Ricci et al., 2020)

2.5.3 Respondent perceptions of child sleep

In the clinical field, the primary source of information on the sleep of the child is the parents. Usually, parental reports are considered a reliable source of information, especially using a sleep diary, compared to both actigraphy (Werner et al., 2008) and polysomnography (PSG). (Combs et al., 2019) However, parental perceptions, as perceptions in general, may be subject to bias. Although sound agreement between different informants and measures can be found, the extent of the agreement varies and different aspects and conditions may impact the variability.

The agreement between parental and child reports and objective measures of child sleep has been studied: For instance, in a study by Combs et al. the difference between child (9–17-year-olds) and parental reports compared to a PSG was 32 minutes and 36 minutes of more total sleep time, 4 minutes and 2 minutes longer sleep onset latency, and 5% and 6% better sleep efficiency. (Combs et al., 2019) The adolescents in the study group did not estimate their sleep variables more reliably than pre-adolescents.

In a study on 8-year-olds, where the sleep diary was completed separately both by the children themselves and their parents, the parents estimated the child's sleep times more accurately than the child. (Mazza et al., 2020) Further, in 2017 Becker et al. studied the agreement of maternal and paternal perceptions on child sleep problems using a questionnaire, the Children's Sleep Habits Questionnaire. The correlation between maternal and paternal perception of the child's sleep problems was strong (Becker et al., 2017).

A Finnish study found that based on parental and child reports, 32% of the eight- to nine-year old children had sleep problems. However, only a quarter (23%) of these were reported by both the parent and the child. (Paavonen et al., 2000) Based on the results, the study group stressed the importance of avoiding using only one informant in child sleep examinations where possible.

2.5.4 Biases in sleep related perceptions

Adult studies have shown that poor sleepers exhibit an attentional bias, where they pay more attention towards sleep related stimuli. (Harris et al., 2015) For instance, in an experimental study, attendees with insomnia recognised more rapidly the removal of sleep related items from a picture than the removal of neutral items. (Marchetti et al., 2006) This sleep related attentional bias has also been evidenced in children of parents with insomnia, where it took longer for these children to process sleep related words than non-sleep related when compared to children of well-sleeping parents. (Ellis et al., 2016) This slower processing speed is thought to arise from the concerns related to the particular words. (Williams et al., 1996)

On the other hand, attentional biases can come in many forms, and it may be difficult to decipher, which informant gives the most accurate report. As preschool children are not yet able to accurately describe their perceptions, to study the impact of these biases in the case of a child's own views on their sleep we have to rely on studies on school-aged and older children.

In the case where the child has a chronic condition, a study on adolescents with inflammatory bowel disease (IBD), for example, showed that parents of the IBD patients reported more child sleeping problems, including nightmares, difficulties falling asleep and daytime tiredness, than the parents of healthy controls. (Pirinen et al., 2010) The adolescents themselves did not report more sleeping problems than their peers. Finding the source of bias in these types of setting can be troublesome. For instance, as the researchers pointed out, the same phenomenon was evidenced in a study on school-aged children with juvenile rheumatoid arthritis. In this study, the children's self-reports did not vary from those of the controls, but polysomnography showed that the children with arthritis had 90% more arousals and awakenings and their sleep was lighter. (Zamir et al., 1998) It seems that the children with juvenile rheumatoid arthritis were so used to sleeping badly that they had become to consider it normal. Whether this was the case for the children with IBD as well, we do not know in the absence of objective sleep recordings. However, a cross-sectional study on over 800 children from a non-clinical setting also discovered that the school-aged children rated their sleep quality as being better than their parents did. (Gomes & Martins, 2021)

When comparing parental reports to objective findings, a study on children with ADHD found that children with ADHD or another psychiatric diagnosis had a longer sleep onset delay than the controls without these diagnoses when the sleep was examined objectively by actigraphy. (Hvolby et al., 2014) However, the study group also realised that parents of children with ADHD overestimated the sleep onset delay of their children even when the actigraphy results were factored in, compared to the parents of the controls. (Hvolby et al., 2014)

Many other aspects impact the parental perceptions of child sleep. In addition to the socioeconomic status of the family, (Williamson et al., 2019) the neighbourhood also modifies how the parents report on child sleep. How much child sleep problems alter the caregiver's sleep impacts the caregiver's reports of child sleep problems more in disadvantaged neighbourhoods than in advantaged neighbourhoods. In the latter the report relies in a higher degree on the child's sleep time. (Lupini et al., 2022) Further it seems that culture also impacts how the sleep of the child is perceived. In an international study on the sleep of 30,000 children up to three-year-old, Asian parents had high levels of complaints about child sleep related problems compared to parents from predominantly Caucasian countries. (Sadeh et al., 2011) This may associate with the observation that in Asian countries the children have later bedtimes and are likely to room share with the parents. (Mindell et al., 2010) The latter has been associated with increased parental observations, but not complaints, of different child behaviours at night. (Dyer et al., 2007)

2.5.5 Impact of poor sleep on the well-being of the parent and parenthood

In addition to the impact of poor sleep on a person's overall health (Liew & Aung, 2021; Ruiz-Castell et al., 2019) and cognitive performance, (Banks & Dinges, 2007; Wild et al., 2018) many effects of poor sleep specifically on parenthood have been discovered.

Sleep deprivation has been shown to weaken the ability to recognise emotions, especially mild anger and happiness, (Van Der Helm et al., 2010) and symptoms of insomnia seem to associate with poorer emotional functioning, not being able to control one's emotions or reacting with stronger emotions than usual. (Sørengaard et al., 2021) Both of these skills, that is recognising emotions in a child and being able to control one's own emotions, are needed daily in the life of parents. Furthermore, sleep deprivation seems to lower the threshold as to what a person experiences as stressful, (Minkel et al., 2012) and lengthens the time it takes for a person to switch between tasks. (Chua et al., 2017; Haavisto et al., 2010) For parents, whose task often includes juggling different activities and the needs of many, while simultaneously setting limits and ensuring that these are followed, the declining tolerance to stress and the difficulties of multi-tasking may have remarkable consequences.

These consequences have been identified in studies. In an actigraph study, mothers with objectively recorded sleep problems displayed less positive parenting both at the time of the sleep recording (Chary et al., 2020; McQuillan et al., 2019) and one year later, (McQuillan et al., 2022) and mothers with more subjective sleeping problems reported more dysfunctional parenting. (McQuillan et al., 2019)

The impact of poor sleep on parenthood already begins during the pregnancy: maternal sleep problems during pregnancy associate with post-natal depression. (Pietikäinen et al., 2019) Depressive symptoms by the mother or both parents have been shown to later associate with the child's emotional problems at 2 and 5 years. (Pietikäinen et al., 2020)

Preschool children may not be able to express themselves how they experience poor parental sleep and its impacts on their well-being. Hence, this has been studied in older children. In 2009, Brand et al. asked 300 adolescents about their sleep quality and the sleep quality of their parents. (Brand et al., 2009) The study group discovered that poor maternal sleep, evaluated by the adolescent, was associated with poor adolescent sleep and elevated symptoms of anxiety and depression, and that this impact was conveyed through poor parenting. Associations between the adolescent perceived poor sleep quality of the father and the sleep and mental well-being of the adolescent themselves were very small or not found at all. Evidently, it seems that the cognitive impacts of poor sleep, at least that of the mothers, do change parental behaviour to such a degree that it has implications for the child as well.

2.6 Sleep and well-being of internationally adopted children

For an individual child, adoption is a life changing event. Children entrusted to international adoption have always lost their parents, often lived in institutions or other inadequate conditions, and at times been brutally maltreated. The change into safe and caring surroundings initiates rapid catch-up processes, which last for years. (Ivey et al., 2021; van Ijzendoorn & Juffer, 2006) It also seems that due to the early adversary conditions the utilisation of health care is much higher in internationally adopted children than their peers living with their biological families. (Graff et al., 2015)

Among internationally adopted children, the prevalence of infectious diseases, e.g. parasites, hepatitis and tuberculosis are higher than in the general population. (Nielsen et al., 2020) Additionally, other conditions such as structural defects, growth retardation, and developmental delay are also associated with being internationally adopted. (Lapinleimu et al., 2022) Higher incidences of precocious puberty, (Teilmann et al., 2006) iron insufficiency, (Fuglestad et al., 2008) untreated cleft lip and/or palate, (Schölin et al., 2019; Werker et al., 2017) and anorectal malformations (Lane et al., 2016) have been reported in internationally adopted children.

The quality of the parental attachment impacts how the adoptee adjusts to their new surroundings (Barone et al., 2017) and the timing of adoption impacts the degree to which the adversary conditions of the pre-adoptive setting impact the child. (Bick et al., 2022) Due to the early life adversary conditions, group differences on mental health problems have been found between internationally adopted children and their non-adopted peers. (Askeland et al., 2017) Further, Finnish studies have shown that internationally adopted children have more learning disabilities than non-adopted children (Raaska, Elovainio, et al., 2012) and that being a victim of bullying is more prevalent in international adoptees in grades 3-4 compared to non-adopted children; however, the difference diminishes during the following school years. (Raaska, Lapinleimu, et al., 2012)

In studies based on parental reports, internationally adopted children seem to have more sleep problems than non-adopted children. (Rajaprakash et al., 2017; Schenkels et al., 2018; Tan et al., 2017) However, when examined by an objective method, the sleep of adoptive preschool children is not significantly worse than that of children living with their biological families. (Heikkilä et al., 2022) Indeed after arriving in their new families, internationally adopted children spend a long time in bed and sleep longer than their non-adopted peers. These small differences seem to diminish even further during the first year in the new family.

2.7 Chronotype

2.7.1 Definition of chronotype and its development during the lifespan

A person's preference for the distribution of sleep and wakefulness during the 24-hour day is called chronotype (Roenneberg et al., 2003) and is partly genetic. (Kalmbach et al., 2017; Maukonen et al., 2020; Morales-Muñoz et al., 2021; Vink et al., 2001) Those with an early chronotype prefer waking up early in the morning, being the most active during the morning hours and going to bed early in the evening. In colloquial language these people are often called "larks". "Owls", in turn, possess a late chronotype. Without outside restrictions, "owls" wake up late, perform their best in the evening and prefer going to bed late at night. (Roenneberg et al., 2003)

One of the indigenous factors impacting a person's circadian rhythm is the hormone melatonin, which enhances sleep. In adults and in dim lighting, the secretion of melatonin begins approximately two hours before sleep onset and 14 hours after waking up. (Burgess et al., 2003) The time when melatonin secretion begins is called dim light melatonin onset (DLMO) and can be used when examining an individual's circadian rhythm and whether it is entrained (synchronised) with the 24 h hour rhythm or free running. (Pandi-Perumal et al., 2007) Studies have shown that the administration of light, especially blue light, is one of the most important Zeitgebers, and its impact can also be seen in DLMO. (Burgess et al., 2003; Gomes et al., 2021) For different chronotypes, additional to the timing of DLMO, (Ruiz et al., 2020; Zerbini et al., 2021) bodily temperature (Horne & Ostberg, 1976) and physical activity measured with actigraphy (see Chapter 2.8.2), (Schneider et al., 2021) has been shown to vary.

The diurnal rhythm of small children usually favours the early morning hours. As the child grows, the daily rhythm may shift slowly towards the evening and in the adolescence a shift of nearly two hours towards the evening takes place. The chronotype then shifts back towards the morning in early adulthood. (Evans et al., 2021; Randler et al., 2017)

Roenneberg et al., the developers of the widely used Munich Chronotype Questionnaire, propose considering chronotype a state rather than something that stays unchanged despite changing surroundings, which would be a trait. (Roenneberg et al., 2019) They discuss that the inclination towards a certain type of timing of activity and sleep during the day i.e., morningness or eveningness, seems quite stable, but the impact and strength of the Zeitgebers affect how the chronotype is displayed. They also note that the effect of the Zeitgebers only lasts as long as these are present. However, in some follow up studies of up to 20 years, the chronotype has seemed to be a quite stable construct. (Druiven et al., 2020; Kuula et al., 2018)

2.7.2 Impact of chronotype on health and well-being

According to research, the main impact of the chronotype on health is mediated through the construct of social jet lag. (Roenneberg et al., 2019; Wittmann et al., 2006) This refers to how, especially evening type, people are forced to act against their intrinsic clock and get up early to go to work and school because of the way the society is scheduled. By doing this, evening types often suffer from sleep imbalance because they do not go to bed as early as they need to and wake up in the morning before they have had enough sleep. This social jet lag has been evidenced in children as young as six–year-olds (Randler et al., 2012) and its degree increases as the child grows. (Clara & Allen Gomes, 2020)

A late chronotype and the social jet lag it may lead to associate with many different adverse outcomes, such as increased risk for depression, (Haraden et al., 2017) and metabolic syndrome. (Anothaisintawee et al., 2017; Koopman et al., 2017)

In four-year-old children, an evening chronotype has already been associated with shorter nocturnal sleep on weekdays and more sleep problems compared to morning type children. (Jafar et al., 2017) Due to this, evening type children exhibit more behavioural problems (Doi et al., 2015) and the bedtime struggles in the evening lead to more conflicts with parents compared to morning type children. (Zimmermann, 2016)

The impact of the chronotype is not only confined to the individual themselves as a maternal late chronotype has been shown to increase infant sleep problems (Morales-Muñoz et al., 2019) and being a morning type person in an evening type family induces daytime somnolence and increases caffeine consumption. (Pereira-Morales et al., 2019)

Further, in an Australian study on 5,000 four- to five-year-olds, the evening type of children were associated with: a poorer quality of life of the child and maternal depression at baseline, poorer psychosocial and physical quality of life, a higher body mass index and more maternal, but not paternal, depressive symptoms during three years of follow-up. (Quach et al., 2016)

2.8 Methods of evaluating sleep

2.8.1 Polysomnography

Polysomnography (PSG) is considered the golden standard of sleep registration. The examination includes the recording of brain activity by electroencephalogram, eye movement by electro-oculogram, muscle tension by electromyogram and heart rate by electrocardiogram. Using the above-mentioned data, PSG can register the precise moment of falling asleep and waking up as well as the different stages of sleep. However, the recording is laborious and time consuming. The subject either sleeps the night at the sleep laboratory or, when in-home equipment is being used, the electrodes are installed at the laboratory and the subject sleeps at home and returns the equipment the next day. A specialist then evaluates the data.

The PSG results are objective and there is no possibility of bias. The disadvantage is that the equipment, and possibly sleeping in unfamiliar surroundings, can disturb the sleep of the subject and prohibit the evaluation of sleep quality. (Ding et al., 2022) Additionally, the expense often limits the number of recorded nights, which can reduce the reliability of the data as a person's sleep quality may vary from one night to another.

The AASM has developed guidelines for the use of PSG both in respiratory (Aurora et al., 2011) and non-respiratory (Aurora et al., 2012) indications of PSG in children. Due to the characteristics of paediatric populations as patients, these guidelines recommend PSG on children being performed at the clinic, with a caretaker present. (Aurora et al., 2011) According to the guidelines, PSG is required for the diagnosis of OSAS in children. (Aurora et al., 2011) However, the costs reduce the availability of the recording, and if the symptoms of OSAS and the clinical findings coincide, Finnish recommendations allow for the treatment of OSAS with e.g. adenotonsillectomy without a preceding PSG. (Rintahaka, 2021)

For children with non-respiratory indications, the AASM recommends PSG for the following: 1. the diagnosis of periodic limb movement disorder, 2. diagnosing narcolepsy coupled with multiple sleep latency test, and 3. for children with frequent NREM parasomnias, epilepsy, or nocturnal enuresis screening of comorbid sleep disorders. (Aurora et al., 2012)

2.8.2 Actigraphy

To alleviate problems of the laborious execution of the polysomnography, the actigraph has become a frequently used method of recording sleep in the field of sleep research. During the last decades the research community has become more aware of the advantages and pitfalls of the method. (Liguori et al., 2023; Sadeh, 2011; Sadeh & Acebo, 2002)

The device is a bracelet, attached to the examinee's wrist, hip, or ankle. The actigraph records movement in time with an acceleration sensor. This data can be converted into values depicting periods of sleep during the recording on the premise that the motionless time is spent asleep. See Figure 3. A sleep diary is recommended to be used parallel to the actigraphy in order to aid the interpretation of the data. (Tétreault et al., 2018) However, some devices include an event button, which is to be pressed at bedtime and get up time thus diminishing, but not eliminating, the importance of the sleep diary. (Ancoli-Israel et al., 2015) Since an actigraphy records movement, it cannot differentiate between the different stages of sleep, nor can it distinguish lying still but awake from sleeping. Depending on the algorithm used to convert the motoric data into sleep parameters, specificity and sensitivity may vary. (Bélanger et al., 2013) As children are more motorically active than adults during sleep, (De Koninck et al., 1992) different algorithms are needed to convert the adult and paediatric data into the desired sleep. (Bélanger et al., 2013)

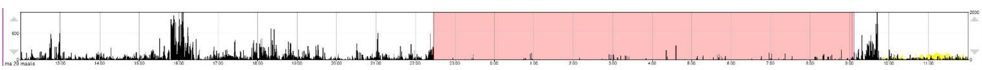

Figure 3. An example of the actogram from the actigraphy recording of an adult. The area marked red is considered sleep.

In general, actigraphy recordings have good sensitivity and specificity to detect sleep. (Liguori et al., 2023) The weakness of the actigraphy in detecting wake after sleep onset increases when this wake time lengthens. (Marino et al., 2013) Further, as the device records movement and cannot distinguish the source of the movement, possible factors disturbing the recording include the nightly movements of the examinee's co-sleeper.

The AASM has recommended in its Clinical practice Guidelines that actigraphy should last for a minimum of 72 hours and a maximum of two weeks. (Smith et al., 2018) In academic research, the recording usually lasts at least a week, and five nights of data is considered sufficient. (Acebo et al., 1999; Antczak et al., 2021)

The different domains of sleep that can be studied with actigraphy are total sleep time, sleep latency, fragmentation index, sleep efficiency, circadian rhythm, cosine peak and light/dark ratio. Of these, the first four describe the amount and restlessness of the sleep of the examinee. Circadian rhythm, cosine peak and light/dark ratio of the actigraphy describe the diurnal rhythm of the examinee. See Table 2.

Table 2. The meaning of the different domains in actigraphy.

DOMAIN	
TOTAL SLEEP TIME	The time spent asleep from bedtime to rise time, including eventual day time naps
SLEEP LATENCY	The lag in falling asleep after bedtime
FRAGMENTATION INDEX	The percentage of all the motorically restless periods of sleep and the percentage of all the immobile periods that are under one minute out of all immobile periods summed up
SLEEP EFFICIENCY	The time slept of the whole time spent in bed
CIRCADIAN RHYTHM	An estimate of the length of the examinee’s intrinsic day
COSINE PEAK	The examinee’s most motorically active period of the day
LIGHT/DARK RATIO	The ratio of the movement counts between 6 a.m. and 6 p.m. and the movement counts between 6 p.m. and 6 a.m

In children, in contrast to parental reports, actigraphy is a valid means to detect wake after sleep onset, which may go unnoticed by the parent if the child’s self-soothing skills have developed sufficiently, thereby leading to an overestimate of sleep time. (Iwasaki et al., 2010; Lam et al., 2011; Tikotzky & Sadeh, 2001) Moreover here, the utilisation of paediatric algorithms is extremely important. (Bélanger et al., 2013) The sleep of children is more restless than that of the adults, and children lie still waiting for sleep onset to a lesser degree than adults. Therefore, the challenges in interpreting paediatric actigraphies vary somewhat from those with adults. (Galland et al., 2014)

The short wakes after sleep onset that go unnoticed by parents may be evident also in the fact that regular sleep times measured with actigraphy are shorter than the recommended amount for the same age children: the regular amount of total 24 hour sleep for a four- to five-year-old in actigraphy is between 8 hours and 9.5 hours (Galland et al., 2012; Sahlberg et al., 2018) but epidemiological studies have shown that children in the same age group sleep between nine to eleven hours according to parental estimates. (Simola et al., 2010) Of further note is that the large variety of actigraphy devices and utilised algorithms complicates comparison between populations and methods of recording actigraphy data. (Van Kooten et al., 2021)

In the clinical field, actigraphy is used to, for example, to follow up on response to treatment and examine child sleep if parental reports are deemed unreliable. (Meltzer, 2018)

2.8.3 Reports and questionnaires

A vast majority of sleep studies have utilized reports in one way or another to inquire about the participants. Many different questionnaires have been developed to facilitate data collection and aid the growth of study populations. Questionnaires are a useful and cost-effective way of data gathering in large study populations. However, they are based on subjective reports and thus exposed to bias or distortions by the respondents. (Werner et al., 2008)

For children, a sleep diary that the parent keeps in real time during the evaluation has proven quite reliable in estimating sleep start and sleep end, however, it has poor reliability on estimating wake time during the night and thereby total sleep time. (Werner et al., 2008) A study using actigraphy and examining the self-perceptions of sleep of 8–9-year-olds found the parental perceptions were more accurate compared to the reports of the child. (Mazza et al., 2020) The sleeping arrangements may further impact how the parent recognises different nightly behaviours and awakenings of the child, as co-sleeping parents notice these easier than parents e.g. sleeping on different floors. (Dyer et al., 2007)

Moreover, previous studies have shown that poorly sleeping adults tend to underestimate their amount of sleep. (Manconi et al., 2010; Means et al., 2003) Whether this bias is also evidenced in reports by poorly sleeping parent on the sleep of their children has not been studied previously.

Different questionnaires have been developed to evaluate the parental perception of the child sleep quality. One of these is the Sleep Disturbance Scale for Children (SDSC), developed by Bruni et al in 1996. (Bruni et al., 1996) In the questionnaire parents report on different aspects of their child's sleep during the previous six months. The 26 items are answered on a Likert-type scale with values 1 to 5 and the answers are calculated as one total score and six sub scores: disorders of initiating and maintaining sleep, sleep breathing disorders, disorders of arousal and nightmares, sleep wake transition disorders, disorders of excessive somnolence, sleep hyperhidrosis. For a detailed list of items for each sub score, see Table 3.

Table 3. The items of each sub score of the Sleep Disturbance Scale for Children by Bruni et al 1996.

NAME OF SUBSCORE	ITEMS
DISORDERS OF INITIATING AND MAINTAINING SLEEP	Sleep duration Sleep latency Going to bed reluctantly Difficulty in falling asleep Night awakenings Difficulty in falling asleep after awakenings
SLEEP BREATHING DISORDERS	Breathing problems Sleep apnoea Snoring
DISORDERS OF EXCESSIVE SOMNOLENCE	Difficulty in waking up Tired when waking up Sleep paralysis Daytime somnolence Sleep attacks Bed-wetting
SLEEP HYPERHIDROSIS	Falling asleep sweating Night sweating
SLEEP WAKE TRANSITION DISORDERS SCORE	Hypnic jerks Rhythmic movement disorders Hypnagogic hallucinations Nocturnal hyperkinesia Sleep talking Bruxism
DISORDERS OF AROUSAL	Sleepwalking Sleep terrors Nightmares

The scale has been proven valid for discriminating children with clinically significant sleep problems in the original target group of 6.5- to 15.3-year-olds (Bruni et al., 1996; Spruyt & Gozal, 2011) but has since been applied to pre-school children (Romeo et al., 2013) and in many different languages. (Eid et al., 2020; Ferreira et al., 2009; Putois et al., 2017; Saffari et al., 2014)

Simola et al. examined the use of the SDSC and the original scoring developed for school-aged children in a Finnish community sample of three- to six-year-old children. (Simola et al., 2010) They examined 904 children living in Helsinki and found a mean of the SDSC total score to be 41.6, with a standard deviation (SD) of 8.3. The values for the sub scores can be seen below in Table 4. According to the Simola study, 45% of the children exhibited difficulties with sleep at least three times a week.

Table 4. Sleep Disturbance Scale Score means and standard deviations within a sample of 904 three- to six-year-old Finnish children according to Simola et al 2010.

	MEAN	SD	CRONBACH'S ALPHA
TOTAL SCORE, POINTS	41.6	8.3	0.8
DISORDERS OF INITIATING AND MAINTAINING SLEEP SCORE, POINTS	12.2	3.1	0.7
SLEEP BREATHING DISORDERS SCORE, POINTS	4.4	1.6	0.7
DISORDERS OF AROUSAL SCORE, POINTS	4.1	1.2	0.4
SLEEP WAKE TRANSITION DISORDERS SCORE, POINTS	9.1	2.5	0.5
SLEEP HYPERHIDROSIS SCORE, POINTS	3.7	2.0	0.6
DISORDERS OF EXCESSIVE SOMNOLENCE SCORE, POINTS	8.1	2.1	0.8

The version of the SDSC validated for pre-school samples also results in six sub scores which differ slightly from the original questionnaire. (Romeo et al., 2013) The sub scores for pre-schoolers are: Parasomnias, disorders of initiating and maintaining sleep, sleep disordered breathing, disorders of excessive somnolence, sleep hyperhidrosis and non-restorative sleep. (Romeo et al., 2013) The alternate sub scores are due to the different prevalence of sleeping problems in pre-school children compared to school aged children.

Questionnaires developed for other aims may also inquire about aspects of the child's sleep. The Child Behavior Checklist developed by Achenbach et al., which examines conductive symptoms of children, asks the respondent whether the child "sleeps more than most kids during day and/or night", or has "trouble sleeping". (Achenbach & Rescorla, 2014) One study suggested caution when using these items on their own as an indicator of different aspects of a child's sleep (Gregory et al., 2011). In the study, the item "sleeps more than most kids" was not associated with objectively measured sleep amounts. However, the item "trouble sleeping" was associated with sleep onset latency both in the sleep diary and the actigraphy.

Different kinds of questionnaires have also been developed for adults. One of these questionnaires is the Jenkins Sleep Scale, which is a questionnaire with four items, each presented with a five-point Likert-type scale. (Jenkins et al., 1988) The questionnaire inquires about the sleep during the previous four weeks with questions on difficulties of falling asleep, repetitive night awakenings, troubles of staying asleep and feeling tired after a normal night's sleep. The Finnish version of the scale has been evaluated to have good internal consistency. (Juhola et al., 2021) The study, which was conducted with 81136 Finnish adults, whose mean age was 52.1 years, averaged a total Jenkins Sleep Scale score of around 6.4 (SD 4.8). (Juhola et al., 2021)

2.8.4 Assessment of chronotype

In addition to actigraphy, different questionnaires for classifying people into morning and evening types have been developed. One of the original ones is the Morningness-Eveningness Questionnaire (MEQ) developed by Horne and Östberg in 1976. (Horne & Ostberg, 1976) They developed a 19-item questionnaire which enquires about a person's feel best rhythm and includes questions on at what time of the day the person would prefer to exercise or work. The questionnaire is still widely used but other questionnaires have also been developed to examine chronotype in adults, such as the Munich Chronotype Questionnaire, which evaluates the chronotype of the person based on bedtimes and wake up times during working days and free days, and the difference between them. (Roenneberg et al., 2003)

A modified and shortened version of the MEQ (mMEQ) has been developed and it consists of six items from the original MEQ (Horne & Ostberg, 1976) which have been proven to account for the main variance in the items in the original scale. (Hätönen et al., 2008) The questions enquire about: how easy it is for the person to wake up in the morning, how alert the person feels during the first 30 minutes after waking up, how easy it would be to exercise at 7-8 a.m., at what time during the day the person would prefer to do manual labour, at what time the person would prefer to start a five hour working day, and with which chronotype the person themself identifies with. The answers are calculated into a total score. Those with a score of 12 points or less are considered morning types. Those with a score from 13 to 18 are considered intermediate and those with a score of 19 points or more are evening types.

In a study based on the data from the FINRISKI 2007 study with over 5000 Finnish participants aged 24 – 75 years and using the mMEQ, 53% of the participants were morning type people, 39% intermediate and 8% of evening type people. (Maukonen, 2021)

To assess the chronotype in children, paediatric questionnaires have been developed. One widely used questionnaire is the Children's ChronoType Questionnaire (CCTQ), (Werner et al., 2009) which consists of 27 items. The first 16 items inquire about time frames for the child's sleep rhythm and ease of falling asleep. The rest of the items, numbers 17-26, are multiple-choice questions. These multiple-choice questions enquire for instance about how easy it is for the child to wake up in the morning if awakened, at what time of the day the child is at their peak performance, and when would the child prefer to go to sleep.

The answers to these can be calculated into midsleep point on free days, a morningness/eveningness scale, and a five-point chronotype score. The morningness/eveningness scale score is calculated from the multiple-choice items 17-26. During the development and validation against actigraphy of the scale, the Cronbach' alpha was 0.81 for these questions. (Werner et al., 2009) The chronotype score is the parent's evaluation of the child's chronotype between 1 (definitely a morning type) to 5 (definitely an evening type). Of the parents in the validation study, 26% categorised their child as being definitely a morning type, 20% as rather a morning than an evening type, 15% as neither, 23% as rather an evening type than morning type, and 14% as definitely an evening type.

3 Aims

The aim of the thesis is to add knowledge to the intricate associations between child and parental sleep. The thesis examines whether parental sleep affects the way the parent experiences and reports on the sleep of their child. The study also investigates whether poor parental sleep is a risk factor for later child sleep problems and whether a late diurnal rhythm for the child associates with parental sleep.

The hypotheses of this doctoral thesis are:

I. Parental sleep quality affects the way parents experience the sleep of their children.

II. The parent's poor sleeping predicts child sleeping problems in a one-year follow-up.

III. The eveningness of a child predicts parental sleeping problems in a one-year follow-up.

Note: The roman numerals refer to the original publications.

4 Materials and Methods

This study was executed as a part of the Finnish Adoption (FinAdo) study, which is an ongoing study on the health and well-being of internationally adopted children in Finland. The population of this study comprised the adopted children in FinAdo in addition to children living with their biological families, who were recruited from the cities of Turku and Kaarina in Finland to act as controls in the other sub studies of the FinAdo study.

The study designs and populations of Studies I, II and III are explained in detail in the following paragraphs. The whole study population was enrolled into the study between October 2012 and December 2016. The data for **Study I**, which is an observational study on children living with their biological parents, was gathered and recorded between January 2014 and February 2015. For **Studies II and III**, which consist of a follow-up of both internationally adopted children and children living with their biological families, the study protocol was initiated with recordings of the internationally adopted children during December 2013, and the second round of all participants was completed in April 2018.

4.1 Population

The populations of the three studies were composed as following: In **Study I**, after receiving information letters, a total of 117 families of non-adopted children aged two- to six-years-old sent their informed consent to participate. However, seven of the children moved away from the Turku and Kaarina area and two children were internationally adopted earlier and therefore excluded from this study. Thus, 108 children with at least one biological parent enrolled, see Figure 4. The aim of the study was to examine the association of poor parental sleep with the parental perceptions of child sleep and somnolence. Hence, the parent who had completed the SDSC of their child was enrolled in the study. Of the child questionnaires, 78 were completed by the mother and four by the father. In 18 families the parents completed the child questionnaires together. In these 18 cases, in order to be able to analyse the associations of the sleep quality of the respondents to the SDSC, the mean of the parental sleep quality scale sum was utilized. Maternal education was however considered in the analysis instead of paternal, as maternal education seems to be linked to child sleep. (Bøe et al., 2012)

Study II endeavoured to uncover whether poor parental sleep predicts a deterioration in later child objective sleep quality, measured with actigraphy, in a population consisting of both children living in their biological families as well as children adopted internationally. A total of 178 families, 99 biological and 79 adoptive, enrolled. The parental questionnaires were completed by 176 mothers and 148 fathers. As only the objective actigraphy analysis was employed as the child sleep marker and not the SDSC, all the parental data could be analysed, leading to data from 324 child-parent-pairs. See Figure 4.

Study III analysed whether the child's chronotype is related to parental sleep quality in a follow-up of a sample including both internationally adopted children and children living with their biological families. Eighty-two of the adoptive families and 58 of the biological families completed the follow-up study with sufficient data for **Study III**. In addition to the data gathered in **Study II, Study III** also utilised the questionnaires on parental and child chronotype. Moreover, in this study, due to the study design, both the maternal and paternal data could be taken advantage of. Hence, the data of 245 parent-child-dyads was analysed. See Figure 4.

4.2 Study design and ethical considerations

Study I included only children living with their biological families. In **Studies II and III**, both biological and adopted children with their families were included. See Figure 4.

Of the study population, the children living with their biological families were recruited to the study by distributing 1560 information letters to 16 day-care centres in Turku and Kaarina, Finland. The internationally adopted children in the study were gathered through information letters distributed through the three adoption agencies operating in Finland, namely the City of Helsinki Welfare Board, Interpedia r.a. and Save the Children Association Finland, to families in the process of international adoption. Families of two- to six-year-old children interested in the study sent their written informed consent to the study group and two appointments were made by telephone for the actigraphy recording. The first appointment was to attach the actigraphy bracelet and hand out the questionnaires; these are described later in detail. During the second appointment, one week later, the actigraph device was removed and the completed questionnaires retrieved.

The study protocol was repeated one year later with the families willing to participate in the follow-up study.

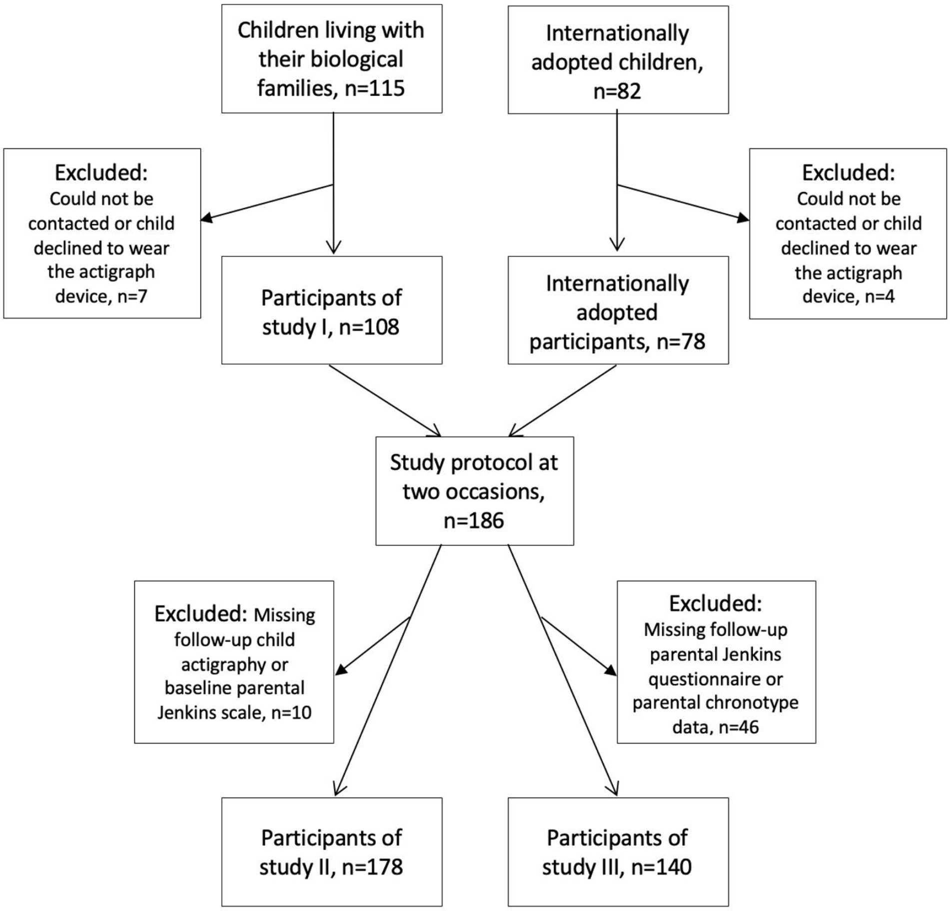

Figure 4. The composition of the study populations.

Study I assessed whether parental sleep is associated with the way parents report on the sleep quality of their children. The inclusion criteria for the children in **Study I** was living with a biological parent. The study protocol consisted of a one-week actigraphy recording and questionnaires for the parent or parents to complete. These questionnaires included background variables, the Sleep Disturbance Scale for Children, (Bruni et al., 1996; Romeo et al., 2013) Jenkins Sleep Scale to evaluate parental sleep, (Jenkins et al., 1988; Juhola et al., 2021) and General Health Questionnaire-12 (Goldberg et al., 1997) (GHQ-12) to assess parental mental health.

Study II examined whether parental sleep problems at baseline associate with more objective child sleep problems recorded in actigraphy in a one-year follow-up. Therefore, the associations of the parental sleep quality measured with Jenkins Sleep Scale at baseline and objective child sleep parameters was analysed using actigraphy in the follow-up. Both children living with their biological families as well as internationally adopted children living with their adoptive parents, were included in this study. The background variables included child age and gender, adoption status and length of follow-up. Due to the choice of statistical methods in **Study II**, all parent-child-pairs whose data for the follow-up child actigraphy and the baseline parental Jenkins questionnaire assessing sleep quality was available, were included and sporadic missing background variables did not reduce the study population.

Study III investigated whether a child's chronotype, i.e. the morningness or eveningness of the child, is related to parental sleep quality at follow-up. The study examined the association of parental sleep quality, measured by the parental Jenkins questionnaire at the one-year follow-up, with different explanatory variables including child morning and intermediate chronotype, measured by the CCTQ; parental sleep quality at baseline, measured by the Jenkins score; child age and gender; parental mental well-being at baseline, measured by the GHQ-12 score; child objective sleep quality at baseline, measured by actigraphy parameters; and the chronotype of both parents, measured by the mMEQ. **Study III** analysed the data of all enrolled children-parent pairs, both adopted and biological, whose follow-up parental Jenkins questionnaire was available.

The Ethics Committee of the Hospital District of Southwest Finland approved the study, and all participating families gave their written informed consent to participate in the study.

4.3 Potential background factors and mediators

The parents were asked to state their date of birth, education, and occupation. They were also requested to provide marital status, and the number of siblings of the child who participated in the study.

Parents completed questionnaires on the child's age, short-term and long-term illnesses, conditions, and medications. They answered questions concerning the child's sleeping arrangements, and whether the child was adopted.

In **Study I** the mean age of the children was 4.0 years and the standard deviation (SD) 1.30 years. The mean age of the mothers was 36.2 (SD 4.9) years and that of the fathers 38.3 (SD 5.2) years. For more detail, see Table 5 and Table 6. A total of 92 children completed the actigraphy with data from five nights or more. Two children completed only four nights of actigraphy. Because the results remained unchanged after excluding these two children, it was decided to include these subjects in the study, see the Results Chapter.

Study II participants included 79 internationally adopted children and 99 children living with their biological families. Roughly half of them, 57% (100 children) were girls, 44% (79 children) were adopted, and the mean age at baseline was 4.1 (SD 1.6) years. The internationally adopted children had arrived in the Finnish families on average 8.4 (SD 7.2) months before taking part in the study. For details see Table 5**.**

Study III included 140 children, of whom 67 (48%) were girls and 82 (57%) adopted. Mothers of 137 children and fathers of 108 children participated. The mean length of follow-up was 1.31 (SD 0.47) years. Details of the participants can be seen in Table 5.

Table 5. Characteristics of the participants in the Studies I, II, and III.

	STUDY I[1]	STUDY II[1]	STUDY III[2]
CHILD PARAMETERS			
N	**100**	**178**	**140**
CHILD AGE, YEARS MEAN (SD)	**4.0 (1.3)**	**4.1 (1.6)**	**5.1 (1.8)**
GENDER BOY, N (%)	**50 (50)**	**78 (44)**	**73 (52)**
CHILD ADOPTED, N (%)	**0**	**79 (44)**	**82 (57)**
MATERNAL PARAMETERS			
N	**98**	**176**	**137**
MATERNAL AGE, YEARS MEAN (SD)	**36.2 (4.9)**	**38.3 (5.6)**	**38.7 (5.6)**
LOWER MATERNAL EDUCATION, N (%)[3]	**18 (18)**	**N/A**	**51 (45)**
HIGHER MATERNAL EDUCATION, N (%)[4]	**80 (82)**	**N/A**	**62 (55)**
PATERNAL PARAMETERS			
N	**91**	**148**	**108**
PATERNAL AGE, YEARS MEAN (SD)	**38.3 (5.2)**	**40.4 (4.7)**	**40.7 (5.9)**
LOWER PATERNAL EDUCATION, N (%)[3]	**33 (35)**	**N/A**	**56 (40)**
HIGHER PATERNAL EDUCATION, N (%)[4]	**79 (64)**	**N/A**	**62 (44)**

[1]ages at the baseline, [2]ages at the follow-up, [3]High school, upper secondary or vocational school, [4]postsecondary vocational education or university

Table 6. Additional characteristics of the Study I participants.

CHARACTERISTIC	NUMBER OF RESPONSES	VALUE
CHILDREN	100	
CHRONIC ILLNESS, NUMBER OF CASES (%)	99	15 (15)
LONG-TERM MEDICATION, NUMBER OF CASES (%)	99	13 (13)
CURRENT MEDICATION, NUMBER OF CASES (%)	99	18 (18)
NUMBER OF SIBLINGS, MEAN (SD)	91	0.75 (0.82)
WINTER/SUMMER AT TIME OF ACTIGRAPHY, N (%)	87	36 (41) /51 (59)
ROOM-SHARING WITH PARENTS, N (%)	95	25 (26)
RESPONDENT OF THE CHILD'S QUESTIONNAIRES	**100**	
MOTHER, N (%)		78 (78)
FATHER, N (%)		4 (4)
PARENTS TOGETHER, N (%)		18 (18)
PARENTAL MARITAL STATUS, NUMBER OF RESPONSES	97	
MARRIED, N (%)		58 (59.8)
COHABITATION, N (%)		18 (18.6)
SINGLE PARENT, N (%)		21 (21.6)

Characteristics of the Study I participants used only in Study I. Modified from Table 1 from in Study I.

4.4 Child questionnaires

4.4.1 Sleep disturbance scale for children

In **Study I**, parental perceptions on child sleep were investigated on using the sleep disturbance scale for children (SDSC). The scale was developed for school age children (Bruni et al., 1996) but has since been validated for children of ages 3 to 6 years. (Romeo et al., 2013; Simola et al., 2010) The scale consists of 26 items which can be calculated into one total score and six sub scores for different sleep domains: parasomnias, disorders of initiating and maintaining sleep, sleep disordered breathing, disorders of excessive somnolence, sleep hyperhidrosis, and non-restorative sleep. The Cronbach's alpha in this sample was 0.76. The SDSC scores at baseline in **Study I** can be seen in Table 7. The items included in each of the sub scores are described in the Chapter 2.8.3.

Table 7. Scores for the Sleep Disturbance Scale for Children at baseline in Study I. Mean age of the population 4 years. T-scores are from a study by to Bruni et al. 1996 using a sample of 6- to 15-year-old children.

	N	MEAN, POINTS	SD, POINTS	MINIMUM (T-SCORE), POINTS	MAXIMUM (T-SCORE), POINTS
TOTAL SLEEP DISTURBANCE SCALE FOR CHILDREN SCORE	100	39.38	7.48	27 (40)	63 (86)
DISORDERS OF INITIATING AND MAINTAINING SLEEP SCORE	102	12.27	3.44	7 (52)	27 (100)
SLEEP BREATHING DISORDERS SCORE	101	3.78	1.04	3 (31)	8 (79)
DISORDERS OF AROUSAL SCORE	101	3.84	1.21	3 (47)	10 (100)
SLEEP-WAKE TRANSITION DISORDERS SCORE	101	9.18	2.42	6 (41)	17 (87)
DISORDERS OF EXCESSIVE SOMNOLENCE SCORE	101	7.66	2.05	5 (42)	14 (77)
SLEEP HYPERHIDROSIS SCORE	100	2.67	1.01	2 (45)	6 (69)

The total score and the sub scores of the SDSC in this study are in line with previous studies made by Simola et al. (Simola et al., 2010). However, they are higher than those of the control group in Bruni et al. 1996, but lower than the children with sleep disorders in the Bruni study. The children in the study by Bruni et al. were older than the population of this study and therefor their sleep is expected to be less disturbed. However, it seems that some of the children in this study were suffering from clinically significant difficulties in initiating and maintaining sleep, disorders of arousal, and sleep-wake transition disorders as the T-scores of the maximum points for those sub scores were very high. This assumption of outliers is supported by the fact that the standard deviations were relatively low.

4.4.2 Children's ChronoType Questionnaire

Study III utilised the Children's ChronoType Questionnaire (CCTQ), (Werner et al., 2009) which was translated from English into Finnish by a professional translator. To ensure the validity of the translation, the Finnish translation was translated back to English by another professional translator and the result corresponded to the original.

CCTQ was originally developed to examine four- to eleven-year-old children (Werner et al., 2009), but has since been considered valid for children over 30 months of age. (Simpkin et al., 2014)

In the current sample, the morningness/eveningness score, which is calculated from items 17-26, see Figure 5, was used and the values were categorised as following: under 23 points indicating morning type, 23-32 points intermediate type and 33 or higher points representing evening type. Of the children with chronotype data, 35 children (25.9%) were classified as morning type, 75 (55.6%) as intermediate, and 25 (18.5%) as evening type children.

4.5 Parental questionnaires

4.5.1 Jenkins Sleep Scale

Parental sleep quality was evaluated both at the baseline and follow-up with the Jenkins Sleep Scale (Jenkins et al., 1988), which consist of four multiple-choice items enquiring about the previous two weeks' sleep. A high sum score indicates poor sleep quality.

Study I employed the Jenkins Sleep Scale score of the parent who had completed the child's questionnaires. If the parents had completed the questionnaires together, the mean of the parents' Jenkins Sleep Scale score was used. The mean of the Jenkins scores included in the study was 9.69 (SD 4.16). The Cronbach's alpha for the population in **Study I** was 0.78.

Study II and **Study III** used the mean of the item means of the Jenkins scale and consisted of the questionnaires being completed at two different time points. The Cronbach's α for maternal sleep in **Study III** at the two registrations were 0.67 and 0.77, and paternal sleep was 0.76 and 0.78, respectively. The baseline item means for the maternal sleep quality were 2.4 (SD 0.9) in **Study II** and 2.5 (SD 0.9) in **Study III**. The corresponding values for the paternal sleep quality were 2.3 (SD 1.0) and 2.5 (SD 1.0), respectively.

Directions: For each of the following questions, please select the answer that best describes your child. Make your judgments based on how the behavior of your child was in recent weeks. There are no "right" or "wrong" answers.

17. *If your child has to be awakened, how difficult do you find it to wake your child up in the morning?
a. very difficult b. fairly difficult c. moderate difficult d. slightly difficult
e. not at all difficult/my child has never to be awakened

18. *How alert is your child during the first half hour after having awakened in the morning?
a. not at all alert b. slightly alert c. moderate alert d. fairly alert e. very alert

19. Considering your child's "feeling best" rhythm, at what time would your child **get up** if he/she could decide by him/herself and if he/she were entirely free to plan the day (e.g., vacation)?
a. prior to 6:30 am b. 06:30 - 7:14 am c. 7:15 - 9:29 am d. 9:30 - 10:14 am
e. after 10:15 am

20. Considering your child's "feeling best" rhythm, at what time would your child **go to bed** if he/she could decide by him/herself and if he/she were entirely free to plan the next day (e.g., weekend)?
a. prior to 6:59 pm b. 7:00 - 7:59 pm c. 8:00 - 9:59 pm d. 10:00 - 10:59 pm
e. after 11:00 pm

21. Let's assume that your child has to be at peak performance for a test that will be mentally exhausting for 2 hours. Considering your child's "feeling best" rhythm and that you are entirely free to plan your child's day, which ONE of the three time intervals would you choose for the test?
a. 7:00 – 11:00 am b. 11:00 am – 3:00 pm c. 3:00 – 8:00 pm

22. Let's assume that you have decided to enroll your child in an athletic activity (e.g., swimming). The only class available meets twice a week at 7 to 8 am. How do you think he/she will perform?
a. would be in very good form b. would be in good form c. would be in reasonable form
d. would find it difficult e. would find it very difficult

23. At what time in the evening does your child seem tired and in need of sleep?
a. prior to 6:30 pm b. 6:30 - 7:14 pm c. 7:15 - 9:29 pm d. 9:30 - 10:14 pm
e. after 10:15 pm

24. *If your child had to get up every day at 6 am, what do you think it would that be like for him/her?
a. very difficult b. rather difficult c. moderate difficult
d. a little difficult, but not a great problem e. not at all difficult

25. *If your child always had to go to bed at ____, what do you think it would be like for him/her? (for 2 years old: 06:00 pm; for 2 to 4 years old: 06:30 pm; for 4 to 8 years old: 07:00 pm; for 8 to 11 years old: 07:30 pm)
a. very difficult b. rather difficult c. moderate difficult
d. a little difficult, but not a great problem e. not at all difficult

26. When your child wakes up in the morning, how long does it take to be fully awake?
a. 0 minutes (i.e., immediately) b. 1 to 4 minutes c. 5 to 10 minutes d. 11 to 20 minutes
e. ≥ 21 minutes

Directions: After answering the above questions, you may have a feeling which "Chronotype" or "Time-of-Day type" your child is. For example, if your child would like to sleep quite a bit longer on "Free Days" compared to "Scheduled Days" or if it is difficult for your child to get out of bed on Monday mornings, then he/she is more likely to be an Evening Type person (a "Night Owl"). If your child, however, regularly wakes up and feels perky once he/she gets out of bed, and your child prefers to go to bed rather early than late, then he/she is more likely a Morning Type person (a "Morning Lark"). Please categorize your child using one of the following choices. Please choose only one category!

27. My child is...
- ☐ Definitely a Morning Type
- ☐ Rather a Morning Type than an Evening Type
- ☐ Neither a Morning nor an Evening Type
- ☐ Rather an Evening Type than a Morning Type
- ☐ Definitely an Evening Type
- ☐ I do not know

The M/E score is derived by adding points from answers 17-26 (a=1, b=2, c=3, d=4, d=5), except as indicated by *, where point values has to be reversed.

Figure 5. Items 17-26 of the Children's ChronoType Questionnaire were used to calculate the morningness/eveningness score used in Study III. Reprinted from Werner H et al. (2009) Assessment of Chronotype in Four- to Eleven-Year-Old Children: Reliability and Validity of the Children's ChronoType Questionnaire (CCTQ), Chronobiology International, 26:5, 992-1014. Permissions and Copyright Taylor and Francis Group.

4.5.2 General Health Questionnaire-12

To assess the parental mental well-being as a background factor in **Study I and III**, the parents were asked to complete the General Health Questionnaire 12 (GHQ-12) (Goldberg et al., 1997) at both registrations. The scale evaluates the person's mental well-being for the previous week and comprises 12 questions on a four-point-rating scale. For a list of the items see

Table **8**. As a precaution, the second item was omitted from the analyses of **Study I**. The item enquires about lost sleep due to worry. However, it has been shown unreliable for screening sleeping difficulties. (Lallukka et al., 2011)

Table 8. Items of the General Health Questionnaire-12.

HAVE YOU RECENTLY
1. BEEN ABLE TO CONCENTRATE ON WHAT YOU'RE DOING?
2. LOST MUCH SLEEP OVER WORRY?
3. FELT YOU WERE PLAYING A USEFUL PART IN THINGS?
4. FELT CAPABLE OF MAKING DECISIONS ABOUT THINGS?
5. FELT CONSTANTLY UNDER STRAIN?
6. FELT YOU COULDN'T OVERCOME YOUR DIFFICULTIES?
7. BEEN ABLE TO ENJOY YOUR NORMAL DAY-TO-DAY ACTIVITIES?

There are two scoring methods for the GHQ-12. (Goldberg et al., 1997) As the rating scale has four choices, these choices can be scored either 0-1-2-3 or 0-0-1-1. In **Study I**, the former scoring method was used. In **Study III**, the items were transformed into values in a similar fashion, but the mean of the item means was utilised.

In **Study I**, the mean of the maternal GHQ-12 score was 21.58 (SD 4.49). The Cronbach's alpha for the population in **Study I** was 0.87. In **Study III**, the values were calculated separately for maternal and paternal scores. The mean of the maternal GHQ-12 items was 2.0 (SD 0.4), corresponding to a total score mean of 24, and that of the father 1.8 (SD 0.4), corresponding to a total score mean of 21.6. The Cronbach's alphas were 0.88 and 0.87, respectively.

4.5.3 Morningness-eveningness of the parent

In **Study III**, the chronotype, or morningness or eveningness of the parent was evaluated by a modified version of the Morningness-Eveningness Questionnaire (mMEQ). (Hätönen et al., 2008) In **Study III**, of the mothers who had completed the mMEQ, 56 mothers (40.4%) were of morning type, 58 (42%) intermediate and 24

(17.4%) of evening type. The corresponding values for the fathers were: 52 (47.7%) morning type fathers, 50 (45.9%) intermediate, and 7 (6.4%) evening type fathers. The distribution of the mMEQ scores of the parents seemed to be skewed towards morningness while the CCTQ scores seemed to be distributed relatively normally. Frequencies of children's and parents' chronotypes are reported in Figure 6.

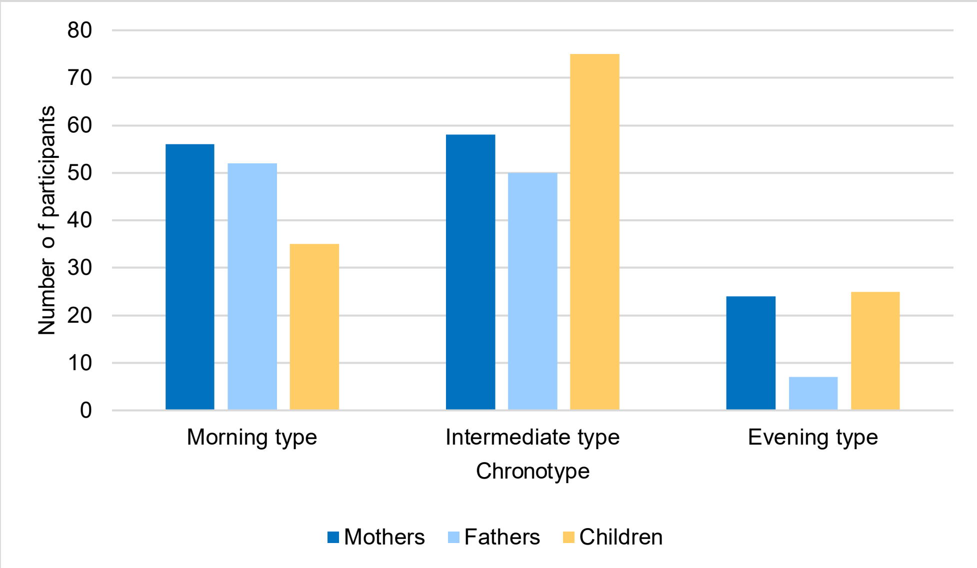

Figure 6. The distribution of the chronotypes of the participants.

4.6 Actigraphy

All **Studies I-III** used actigraphy to assess the sleep parameters of the child. The actigraph used in this study was a GeneActiv Original bracelet created by Activinsights Ltd (Cambridgeshire, United Kingdom). The device is validated for examining the sleep of children (Antczak et al., 2021) in addition to classifying the intensity of physical activity in adults (Esliger et al., 2011) and children (Phillips et al., 2013).

At the first study appointment, the actigraph bracelet was placed on the child's non-dominant wrist. The parents were instructed to press the actigraph event button at bedtimes and wake up times of the child and remove the bracelet before bathing and contact sports. The parents were also asked to keep a sleep log to aid the analysis of the actigraph data. There they were to enter the time when the child had gone to bed and woken up, and eventual times and reasons for removal of the actigraph. At the second appointment, the actigraph and the sleep diary were returned. Here, the parents had the opportunity to report any irregularities or complications during the recording. Trained research assistants, supervised by a clinical neurophysiologist, ran the data through the analysis using the Actiwatch software. The clinical neurophysiologist then interpreted the data into the required parameters. If button presses on the actigraph were missing, the last activity peak before a motorically calm period was interpreted as the bed time and then the get up time was assessed as the first activity peak after a motorically calm period. These were then compared with the sleep log. A few button presses on the actigraphs were missing but no discrepancies between the actigraphies, or actigraph button presses and sleep diaries were found.

The GeneActiv original bracelet utilises a micro-electro-mechanical-system sensor, which detects acceleration in three dimensions on a range of +/- 8 g and a resolution of 3.8 g. The sampling frequency was set to 50 Hz. Since GeneActiv lacks its own software calculated parameters, the software of Actiwatch Activity & Sleep analysis 7 version 7.31 was utilised to interpret the data. (te Lindert & van Someren, 2013)

This software derives activity counts from the x-axis data. The sensitivity of the software was adjusted to medium and the epoch length was set to 1 s. In intervals of 30 s, the highest activity count of each second was summed up. Specific paediatric algorithms were employed to convert these values into Actiwatch 30 s epoch data. A value of 40 per epoch was used to differentiate between wakefulness and sleep: a value below 40 indicated immobility, thus sleep, and a value above 40 was indicative of wakefulness. Sleep start was considered to commence at 10 minutes of immobile epochs including a maximum of 1 epoch with a value over 40. Correspondingly, the end of sleep was placed at the second epoch with a value over 40 after 10 minutes of immobility.

Parameters derived for **Studies I, II and III** from the actigraphy recording were sleep onset time, wake-up time, time in bed, sleep efficiency, sleep fragmentation, actual 24-hour sleep duration, and sleep onset latency. Sleep efficiency portrays the proportion of the time slept of the time spent in bed and sleep fragmentation depicts nocturnal restlessness by summing up the percentage of the time spent moving in bed of the total time in bed and the proportion of short immobility phases out of all immobility phases.

Usually, as well as in the current study, the actigraphy recording lasts for least one week as sleep may vary from night to night. A recording of at least five successfully recorded nights is considered valid. (Acebo et al., 1999) However, in **Study I** two children (2% of the study population) had only four successfully recorded nights. The study results remained the same with these children excluded, and consequently the decision was made to include these children in the study group in **Study I**, as well as in the Studies II and III.

In **Study I**, one child (1%) had 5 successfully actigraph recorded nights and 5 children (5%) had the data of 6 successfully recorded nights. For 91 % (86) of the children the one-week actigraphy recording succeeded completely. Technical problems with the actigraph device was the main reason for missing actigraph data.

On both study occasions, in the first meeting, the actigraph device was placed on the child's non-dominant wrist, but after that the placement of the device was not controlled. At the retrieval of the questionnaires and the actigraph device, the families were asked about their thoughts and feelings on the study protocol. None of the families reported any irregularities that would lead to an exclusion of a part of the recording. Thus, no successfully recorded nights were excluded.

The actigraphy parameters of the non-adopted population of the participants in **Study I** was published by Sahlberg et al in 2018. (Sahlberg et al., 2018) In this report, the children were divided into two- to three-year olds, four- to five-year olds, and six-year-olds and older. The means and standard deviations for the 24-hour sleep time, sleep latency, fragmentation index and sleep efficiency can be seen in Table 9.

Table 9. The 24-hour means and standard deviations of different sleep domains in the actigraphy of the non-adopted population in Study I according to Sahlberg et al 2018.

	TOTAL 24 H SLEEP TIME, H	SLEEP LATENCY, MIN	FRAGMEN-TATION INDEX	SLEEP EFFICIENCY, %
2–3-YEAR-OLDS, MEAN (SD)	8.78 (0.73)	27.9 (14.3)	39.0 (7.2)	76.9 (3.5)
4–5-YEAR-OLDS, MEAN (SD)	8.53 (0.53)	24.1 (11.2)	38.1 (7.1)	78.3 (3.6)
6 YEARS AND OLDER, MEAN (SD)	8.35 (0.4)	18.3 (7.9)	34.2 (8.8)	80.2 (4.3)

Modified from Sahlberg et al 2018

For the whole study population, both internationally adopted children as well as children living with their biological families, at baseline, the 24-hour sleep time mean was 8.9 hours (SD 0.8). Sleep onset latency was 24 minutes (SD 12), the sleep fragmentation index was 39 (SD 8.1), and sleep efficiency 78% (SD 4.6). These values at the follow-up can be seen in Table 10. The differences in actigraphy parameters between the internationally adopted children and non-adopted children of this study population has been previously published by Heikkilä et al. 2022. In summary, the internationally adopted children slept longer and had a longer time in bed than children living with their biological parents. This difference decreased at follow-up.

Table 10. The 24-hour means and standard deviations of different sleep domains in actigraphy at the follow-up of the adopted children, the non-adopted children and all the children.

	TOTAL 24 H SLEEP TIME, H	SLEEP LATENCY, MIN	FRAGMEN-TATION INDEX	SLEEP EFFICIENCY, %
INTERNATIONALLY ADOPTED CHILDREN (SD)	8.9 (0.7)	24 (12)	37.9 (8.5)	78.7 (5.6)
NON-ADOPTED CHILDREN (SD)	8.4 (0.5)	24 (12)	34.6 (7.4)	78.8 (3.8)
ALL CHILDREN (SD)	8.6 (0.6)	24 (12)	36.1 (8.1)	78.8 (4.7)

The actigraphy parameters for the whole population, grouped by age at the time of the follow-up, 1.31 years (SD 0.47) after the first study appointment are shown in Table 11.

Table 11. The 24-hour means and standard deviations of different sleep domains as grouped by age in the actigraphy at the follow-up for the whole study population.

	TOTAL 24 H SLEEP TIME, H	SLEEP LATENCY, MIN	FRAGMEN-TATION INDEX	SLEEP EFFICIENCY, %
<4-YEAR-OLDS, MEAN (SD)	8.9 (0.6)	24 (12)	38.0 (7.3)	77.8 (4.4)
5-6-YEAR-OLDS, MEAN (SD)	8.4 (0.6)	24 (12)	35.3 (8.7)	79.2 (5.0)
>7 YEARS AND OLDER, MEAN (SD)	8.3 (0.5)	24 (12)	32.1 (7.6)	80.9 (4.1)

4.7 Statistical methods

4.7.1 Study I

In **Study I**, which aimed at examining the association of parental sleep quality and the parent's reports on the sleep of the child, linear regression analyses were employed to find associations between the parent-reported child sleep problems, measured using the SDSC total score, and different explanatory variables. The associations between different explanatory factors, including the parental sleep quality, measured by the Jenkins scale, and the symptoms of disorders of excessive somnolence, disorders of initiating and maintaining sleep, and sleep-wake transition disorders, measured by the corresponding SDSC sub scores, were additionally separately analysed.

The analysis consisted of five steps where each step involved adding the impact of explanatory variables onto the previous step's analyses. First, the association of the respondent parent's sleep quality in the Jenkins scale with the parent-reported child sleep problems using the child SDSC score was analysed. Second, the influence of the child's objective sleep quality, measured using actigraphy parameters, i.e. the total 24-hour sleep time and sleep efficiency, was added onto the analyses. In the third step, parental mental well-being, measured by the GHQ-12 (with the sleep item omitted), was added, and in step four, child background factors, such as child age and gender and the existence on medications and illnesses were incorporated into the calculations. The final and fifth step consisted of evaluating the association of the time of year (summer or winter), number of siblings, parental marital status, parental age, and maternal education with the findings of the earlier steps. The analyses were the repeated on each of the studied symptoms of sleep disorders, measured by the SDSC sub scores.

Parents of 18 children had together completed the questionnaires concerning the child. As the aim of the study was to evaluate the associations between the actual sleep and the perceptions of child sleep by the parent who had completed the sleep questionnaire of the child, the aforementioned analyses were replicated without the responses of parents who had completed the child questionnaires together. The results were unchanged leading to the inclusion of those families into the study, see the Results Chapter.

The association between the parental sleep quality and the child sleep parameters in actigraphy was also analysed. Further, the association between parental well-being and parent-reported child sleep problems was investigated. The analyses for **Study I** were carried out on SAS for Windows version 9.3 (SAS Institute, Cary, NC).

4.7.2 Study II

Study II aimed at finding associations between parental sleep quality at baseline and changes in child sleep duration and continuity during a follow-up period. It utilised linear mixed modelling on the statistical program R, version 4.03 and the lmer4 package (R Foundation, Vienna, Austria). The associations between parental sleeping problems, measured using Jenkins scale, and the changes in objective child sleep, using actigraphy sleep parameters i.e., total 24-hour sleep time, sleep latency, sleep efficiency, and fragmentation index, between two measurement points (approximately one year apart) were examined separately for the mother and father's sleeping problems. The associations were adjusted for the length of the follow-up, adoption status, age of the child, gender of the child and the age of the parent. Preliminary analysis showed that the internationally adopted children and children living with their biological parents did not differ from each other. The p-values for the interaction effect between adoption status and parental sleep problems on the sleep parameters of children ranged from 0.061 to 0.956. Hence, the groups were combined for the study.

4.7.3 Study III

Study III examined the association between child chronotype and parental sleep quality at follow-up. The linear regression analyses that were used, were carried out on the statistical program R, version 4.1.1. The analyses included examining factors associated with parental sleep quality, measured by the parental Jenkins scale item mean, at follow-up. The analyses were performed on maternal and paternal data independently and were executed in four steps, where the explanatory factors of each step were added to the previous step's analyses. In step one, the association of the parental sleep quality at baseline, measured using the Jenkins questionnaire item mean; child intermediate chronotype and child morning chronotype, both categorised using the CCTQ; child age at follow-up; child gender; and parental mental well-being at baseline, using the GHQ-12 item mean with the parental seep quality at one year-follow up using the Jenkins scale item mean was examined. The second step added the child's objective sleep quality, using sleep time from the actigraphy at baseline, child sleep fragmentation at baseline, and child sleep efficiency index at baseline, onto the previous analyses. The third step supplemented the preceding analyses with the influence of the parental intermediate and morning type, using the mMEQ; and in the fifth step, the effect of the other parent's chronotype was introduced into the analysis.

5 Results

5.1 Parental sleep quality and parental perceptions of the sleep of their child (Study I)

Parental sleep quality associated with parental reports of child sleep when controlled for using the child's objective sleep quality. The estimate for the association between poor parental sleep and parent-reported child sleep problems was 1.05 (95% confidence interval [CI] 0.633 to 1.47), p= <.001). The poorer the parental sleep was, the higher were the levels of sleep problems of the child reported by the parent and the more symptoms of disorders of excessive somnolence (estimate 0.237 (95% CI: 0.112 - 0.363, p= <.001), disorders of initiating and maintaining sleep (estimate 0.336, 95% CI: 0.149 - 0.522, p= <.001), and sleep-wake transition disorders (estimate 0.311, 95% CI 0.165 - 0.457, p= <.001) the parents reported. In addition, increasing parental age was associated with reported child problems of initiating and maintaining sleep (estimate −0.216, 95% CI: −0.375 - −0.0573, P= .0085). This association did not diminish the influence of the parental sleep quality. See Table 12.

Poor parental sleep was not statistically significantly associated with the child's objective actual 24-hour sleep time (estimate: −0.001; CI: −0.002 - 0.00; p= .27). Nor was the association significant for the child's sleep efficiency (estimate: −0.184; 95% CI: −0.383 - 0.015; p= .07).

The associations of the parental sleep quality with the parent-reported child sleep problems and the different symptoms of sleep disorders were similar in strength when considering the estimates and the number of items per score and sub score.

These analyses were carried out without the data of the two children with only four days of actigraphy recording and the results were unchanged, see Table 13.

Table 12. Associations of the different explanatory factors with parent-reported child sleep quality, measured with the child SDSC total score, and parent-reported symptoms of disorders of excessive somnolence, disorders of initiating and maintaining sleep and sleep-wake transition disorders, measured using the corresponding SDSC sub scores.

	PARENT-REPORTED CHILD SLEEP PROBLEMS[1]		PARENT-REPORTED SYMPTOMS OF DISORDERS OF EXCESSIVE SOMNOLENCE[1]		PARENT REPORTED SYMPTOMS OF DISORDERS OF INITIATING AND MAINTAINING SLEEP[1]		PARENT-REPORTED SYMPTOMS OF SLEEP-WAKE TRANSITION DISORDERS[1]	
	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value
PARENTAL SLEEP QUALITY[2]	1.05 (0.633–1.47)	**<0.001**	0.237 (0.112–0.363)	**<0.001**	0.336 (0.149–0.522)	**<0.001**	0.311 (0.165–0.457)	**<0.001**
ACTUAL SLEEP TIME IN ACTIGRAPHY	-40.4 (-122–41.2)	0.33	-2.42 (-27.0–22.2)	0.84	-26.1 (-62.5–10.4)	0.16	-4.21 (-32.7–24.3)	0.77
SLEEP EFFICIENCY IN ACTIGRAPHY	0.178 (-0.27–0.627)	0.43	0.088 (-0.047–0.224)	0.20	0.045 (-0.156–0.245)	0.66	-0.059 (-0.216–0.098)	0.46
PARENTAL MENTAL WELL-BEING	-0.0719 (-0.442–0.298)	0.70	-0.062 (-0.174–0.049)	0.27	0.023 (-0.142–0.188)	0.78	-0.091 (-0.221–0.038)	0.16
CHILD AGE	-0.491 (-1.93–0.946)	0.50	-0.385 (-0.818–0.049)	0.081	-0.618 (-1.26–0.025)	0.059	0.399 (-0.104–0.902)	0.12
FEMALE GENDER OF THE CHILD	1.25 (-1.92–4.41)	0.43	0.897 (-0.058–1.85)	0.065	0.630 (-0.785–2.05)	0.38	0.004 (-1.10–1.11)	0.99
CHRONIC ILLNESS	-2.33 (-11.8–7.16)	0.62	-1.43 (-4.30–1.43)	0.32	0.290 (-3.95–4.53)	0.89	-0.295 (-3.62–3.03)	0.86
CURRENT MEDICATION	2.70 (-7.64–13.0)	0.60	0.852 (-2.27–3.97)	0.59	0.063 (-4.56–4.69)	0.98	-0.130 (-3.75–3.49)	0.94
PARENTAL AGE	0.334 (-0.690–0.022)	0.065	-0.022 (-0.129–0.086)	0.69	-0.216 (-0.375– -0.057)	**0.0085**	-0.065 (-0.189–0.060)	0.30

NOT SINGLE PARENT VS. SINGLE PARENT	-3.32 (-7.38–0.744)	0.11	-0.376 (-1.60–0.850)	0.54	-1.15 (-2.97–0.666)	0.21	-0.889 (-2.31–0.533)	0.22
MATERNAL EDUCATION:		0.31		0.065		0.57		0.20
-upper secondary shool vs. a university degree	-5.32 (-15.3–4.69)	0.29	-0.957 (-3.98–2.06)	0.53	-1.11 (-5.58–3.37)	0.62	-2.98 (-6.49–0.523)	0.094
-trade school vs. a university degree	-3.66 (-8.29–0.974)	0.12	-1.19 (-2.59–0.204)	0.093	-0.067 (-2.14–2.00)	0.95	-1.34 (-2.96–0.284)	0.10
-post-secondary vocational education vs. a university degree	-2.51 (-6.57–1.56)	0.22	-0.764 (-1.99–0.462)	0.22	-1.19 (-3.00–0.630)	0.20	-0.330 (-1.75–1.09)	0.64
NUMBER OF SIBLINGS	1.20 (-0.90–3.30)	0.26	0.407 (-0.227–1.04)	0.20	0.558 (-0.381–1.50)	0.24	0.144 (-0.591–0.880)	0.70
WINTER TIME	-0.813 (-4.19–2.57)	0.63	-0.146 (-1.17–0.874)	0.78	0.019 (-1.49–1.53)	0.98	-0.293 (-1.48–0.890)	0.62
R-SQUARE	0.461		0.316		0.461		0.371	

[1]Measured with the Sleep Disturbance Scale for Children, [2]measured with the Jenkins Sleep Scale, [3] measured with the General Health Questionnaire -12 score without the sleep question. Modified from tables 2-5 in Study I

Table 13. The association of the parental sleep quality, measured with the Jenkins Sleep Scale score, with the parent-reported child sleep problems and symptoms of different sleep disorders, measured with the SDSC total score and the examined sub scores, when the two children with only four nights of actigraphy were excluded.

	PARENTAL SLEEP QUALITY[1]	
	Estimate (95% CI)	P-value
PARENT-REPORTED CHILD SLEEP QUALITY[2]	1.06 (0.70-1.42)	<.0001
PARENT-REPORTED SYMPTOMS OF DISORDERS OF EXCESSIVE SOMNOLENCE[2]	0.225 (0.097-0.353)	0.0009
PARENT-REPORTED SYMPTOMS OF DISORDERS OF INITIATING AND MAINTAINING SLEEP[2]	0.343 (0.152-0.535)	0.0007
PARENT-REPORTED SYMPTOMS OF SLEEP-WAKE TRANSITION DISORDERS[2]	0.309 (0.159-0.458)	0.0001

[1]Measured with the Jenkins Sleep Scale, [2]measured with the Sleep Disturbance Scale for Children

Linear regression analyses were also carried out without the 18 families, whose parents had answered on the questionnaires together. The associations remained unaffected and for symptoms of two different sleep disorders they grew even stronger: the estimate for the association between the parental sleep quality and parent-reported child sleep problems was 1.17 (95% CI: 0.712 - 1.63, p= <.001) and that for the parental sleep quality and parent-reported symptoms of disorders of initiating and maintaining sleep of the child was 0.461 (95% CI: 0.260 - 0.656, p< .001).

5.2 Parental sleep quality and changes in child sleep during the follow-up (Study II)

The main findings of **Study II** are discussed in the following paragraphs. The associations of the different explanatory variables with the changes in child sleep quality at the follow-up were analysed separately for maternal and paternal variables. The association of maternal sleep quality with changes in objective child sleep quality in the actigraphy recording during the follow-up period (mean 1.31 years, SD 0.47) can be seen in Table 14. These associations, when examining variables including paternal sleep quality, can be seen in Table 15.

The maternal sleep quality, measured by Jenkins scale item mean, was not associated with any changes in the objective child sleep quality at the follow-up. However, poorer paternal sleep quality was associated with a decrease in child sleep efficiency during the follow-up.

In all the analysis, decreases in the child's total sleep time and time in bed recorded by the actigraphy during the follow-up were associated with an older child age, a longer follow-up and being non-adopted. The child being non-adopted, a boy or young lengthened the sleep latency. Older child age and a longer follow-up increased sleep efficiency and decreased sleep fragmentation.

Table 14. Associations with explanatory factors, including maternal age and maternal sleep quality using the Jenkins scale score, with changes in objective child sleep quality: child total sleep time, time in bed, sleep onset latency, sleep efficiency and sleep fragmentation in actigraphy

PREDICTOR	TOTAL SLEEP TIME		TIME IN BED		SLEEP ONSET LATENCY		SLEEP EFFICIENCY		SLEEP FRAGMENTATION	
	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value
LENGTH OF FOLLOW-UP	-0.22	**<0.001**	-0.40	**<0.001**	0.03	0.096	0.85	**0.004**	-2.72	**<0.001**
	(-0.30 – -0.14)		(-0.51 – -0.28)		(-0.00–0.06)		(0.27–1.43)		(-3.67 – -1.77)	
ADOPTED [NO]	-0.35	**0.001**	-0.33	**0.012**	0.06	**0.048**	-0.78	0.335	-1.95	0.176
	(-0.56 – -0.14)		(-0.60 – -0.07)		(0.00–0.12)		(-2.37–0.81)		(-4.79–0.88)	
CHILD AGE	-0.17	**<0.001**	-0.37	**<0.001**	-0.02	**0.019**	1.10	**<0.001**	-1.70	**<0.001**
	(-0.23 – -0.10)		(-0.44 – -0.29)		(-0.04 – -0.00)		(0.65–1.55)		(-2.51 – -0.90)	
CHILD GENDER, BOY	0.01	0.932	0.03	0.767	0.05	**0.028**	-0.25	0.689	-0.75	0.502
	(-0.16–0.17)		(-0.17–0.23)		(0.01–0.10)		(-1.49–0.98)		(-2.96–1.45)	
MATERNAL AGE	-0.00	0.702	-0.01	0.470	-0.00	0.097	0.04	0.521	-0.07	0.541
	(-0.02–0.01)		(-0.03–0.01)		(-0.01–0.00)		(-0.09–0.17)		(-0.31–0.16)	
MATERNAL SLEEP QUALITY	-0.05	0.242	0.07	0.227	0.00	0.940	0.04	0.913	-0.57	0.341
	(-0.14–0.04)		(-0.17–0.04)		(-0.02–0.03)		(-0.62–0.70)		(-1.75–0.61)	
MARGINAL R^2/ CONDITIONAL R^2	0.307 / 0.763		0.480 / 0.767		0.091 / 0.384		0.146 / 0.713		0.183 / 0.761	

Table 15. Associations with explanatory factors, including paternal age and sleep quality, using the Jenkins scale score, with changes in objective child sleep quality: total sleep time, time in bed, sleep onset latency, sleep efficiency and sleep fragmentation.

PREDICTOR	TOTAL SLEEP TIME		TIME IN BED		SLEEP ONSET LATENCY		SLEEP EFFICIENCY		SLEEP FRAGMENTATION	
	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value	Estimate (95% CI)	P-value
LENGTH OF FOLLOW-UP	-0.24 (-0.32 – -0.15)	**<0.001**	-0.39 (-0.52 – -0.27)	**<0.001**	0.03 (-0.00 – 0.06)	0.092	0.64 (0.05 – 1.23)	**0.035**	-2.59 (-3.63 – -1.54)	**<.001**
ADOPTED, NO	-0.32 (-0.54 – -0.11)	**0.003**	-0.31 (-0.55 – -0.07)	**0.012**	0.09 (0.03–0.15)	**0.002**	-0.87 (-2.44–0.70)	0.276	-1.07 (-3.94–1.79)	0.464
CHILD AGE	-0.13 (-0.19 – -0.07)	**<0.001**	-0.35 (-0.42 – -0.27)	**<0.001**	-0.03 (-0.04 – -0.01)	**0.004**	1.27 (0.81–1.74)	**<0.001**	-2.09 (-2.94 – -1.24)	**<0.001**
CHILD GENDER, BOY	-0.03 (-0.21 – 0.15)	0.748	0.06 (-0.15 – 0.26)	0.577	0.07 (0.02–0.12)	**0.010**	-0.61 (-1.95–0.73)	0.371	-0.15 (-2.59–2.29)	0.903
PATERNAL AGE	-0.01 (-0.03 – 0.01)	0.317	-0.01 (-0.03 – 0.01)	0.488	0.00 (-0.00–0.01)	0.356	-0.03 (-0.17–0.11)	0.653	0.07 (-0.18–0.32)	0.574
PATERNAL SLEEP QUALITY	-0.03 (-0.12–0.06)	0.489	0.08 (-0.02–0.18)	0.127	0.02 (-0.00–0.05)	0.112	-0.82 (-1.48 – -0.15)	**0.016**	0.56 (-0.65–1.78)	0.366
MARGINAL R^2/ CONDITIONAL R^2	0.240 / 0.729		0.477 / 0.734		0.089 / 0.433		0.192 / 0.741		0.195 / 0.758	

5.3 Child chronotype and parental sleep quality at follow-up (Study III)

Study III investigated associations of the parental sleep quality at follow-up with child chronotype and other explanatory variables. These variables included child age and gender, parental sleep quality at baseline, measured by the Jenkins sleep scale score, and parental mental well-being, measured by the GHQ-12 score. Significant associations for parental sleep quality at follow-up were found with parental sleep quality at baseline, child intermediate and morning chronotype, see Table 16. Poor parental sleep quality at baseline associated with a poorer parental sleep at the follow-up. Child intermediate and child morning chronotypes measured by CCTQ associated with better parental sleep quality at follow-up. The impact of the morning chronotype was slightly larger than the impact of the intermediate chronotype.

Table 16. Step 1 of the linear regression analyses of Study III: The associations between parental sleep quality, child chronotype, child age and gender and parental mental well-being with parental sleep at follow-up.

PREDICTOR	*MATERNAL*		*PATERNAL*	
	Estimate (SD)	*P-value*	*Estimate (SD)*	*P-value*
SLEEP QUALITY OF THE PARENT AT BASELINE[1]	0.72 (0.55 -- 0.90)	**<0.001**	0.51 (0.34 -- 0.67)	**<0.001**
CHILD INTERMEDIATE CHRONOTYPE[2]	-0.51 (-0.88 -- -0.14)	**0.007**	-0.53 (-0.94 -- -0.11)	**0.014**
CHILD MORNING CHRONOTYPE[2]	-0.69 (-1.12 -- -0.27)	**0.002**	-0.70 (-1.18 -- -0.22)	**0.005**
CHILD AGE AT FOLLOW-UP	0.03 (-0.05 -- 0.10)	0.493	0.05 (-0.04 -- 0.13)	0.284
CHILD GENDER, BOY	-0.13 (-0.40 -- 0.14)	0.331	-0.01 (-0.31 -- 0.29)	0.944
PARENTAL MENTAL WELL-BEING[3]	-0.23 (-0.61 – 0.15)	0.235	0.20 (-0.26 – 0.65)	0.391
ADJUSTED R^2	0.397		0.310	

[1]Measured with the Jenkins sleep scale, [2]measured with the Children's ChronoType Questionnaire, [3]measured with the General Health Questionnaire 12. Modified from tables 4-5 in Study III.

In steps 2 and 3 more predictors were added onto those examined in the previous steps. These steps showed similar results as the first step of the linear regression analyses, see Table 17 and Table 18. For both parents, poor parental sleep quality at the baseline decreased, and both the child intermediate chronotype and child morning chronotype increased parental sleep quality at follow-up.

In step four, the preceding analyses were complimented with the chronotype of the child's other parent, see Table 19. Here the child intermediate chronotype lost its significance as a predictor of paternal sleep quality at the follow-up (estimate -0.41, SD -0.88 - -0.005, p= 0.80). Subsequently, it seems that by considering the chronotype of the mother, the association of the child chronotype with the paternal sleep quality is diminished. However, for maternal sleep at the follow-up, the intermediate child chronotype remained a significant predictor (estimate -0.46, SD -0.89 - -0.04, p= 0.033). Parental sleep at baseline and child morning chronotype continued to predict the parental poor sleep quality at the follow-up and these estimates remained virtually unchanged.

Table 17. Step 2 of the linear regression analyses of Study III: The influence of objective child sleep quality added onto step 1.

PREDICTOR	MATERNAL		PATERNAL	
	Estimate (SD)	*P-value*	*Estimate (SD)*	*P-value*
PARENTAL SLEEP QUALITY AT BASELINE[1]	0.72 (0.54 -- 0.90)	**<0.001**	0.52 (0.35 – 0.69)	**<0.001**
CHILD INTERMEDIATE CHRONOTYPE[2]	-0.53 (-0.91 -- -0.16)	**0.006**	-0.49 (-0.91 -- -0.07)	**0.023**
CHILD MORNING CHRONOTYPE[2]	-0.72 (-1.16 -- -0.28)	**0.001**	-0.70 (-1.18 -- -0.22)	**0.005**
CHILD AGE AT FOLLOW-UP	0.05 (-0.06 -- 0.16)	0.393	0.11 (-0.02 -- 0.24)	0.088
CHILD GENDER, BOY	-0.14 (-0.42 -- 0.13)	0.298	-0.00 (-0.30 -- 0.30)	0.995
PARENTAL MENTAL WELL-BEING AT BASELINE[3]	-0.23 (-0.62 -- 0.15)	0.238	0.17 (-0.28 -- 0.63)	0.454
CHILD SLEEP TIME (H) IN ACTIGRAPHY AT BASELINE	0.02 (-0.24 -- 0.28)	0.861	0.25 (-0.04 -- 0.55)	0.093
CHILD SLEEP FRAGMENTATION INDEX IN ACTIGRAPHY AT BASELINE	-0.00 (-0.02 -- 0.02)	0.909	-0.00 (-0.03 -- 0.02)	0.738
CHILD SLEEP EFFICIENCY INDEX IN ACTIGRAPHY AT BASELINE	-0.02 (-0.07 -- 0.03)	0.419	-0.02 (-0.07 -- 0.03)	0.435
ADJUSTED R^2	0.387		0.309	

[1]Measured with the Jenkins sleep scale, [2]measured with the Children's ChronoType Questionnaire, [3]measured with the General Health Questionnaire 12. Modified from tables 4-5 in Study III.

Table 18. Step 3 of the linear regression analyses of Study III: The influence of the parent's own chronotype added onto step 2.

PREDICTOR	MATERNAL		PATERNAL	
	Estimate (SD)	*P-value*	*Estimate (SD)*	*P-value*
PARENTAL SLEEP QUALITY AT BASELINE[1]	0.71 (0.54 – 0.89)	**<0.001**	0.50 (0.32 – 0.68)	**<0.001**
CHILD INTERMEDIATE CHRONOTYPE[2]	-0.48 (-0.86 -- -0.10)	**0.013**	-0.49 (-0.95 -- -0.03)	**0.038**
CHILD MORNING CHRONOTYPE[2]	-0.68 (-1.12 -- -0.24)	**0.003**	-0.76 (-1.27 -- -0.24)	**0.004**
CHILD AGE AT FOLLOW-UP	0.06 (-0.05 – 0.18)	0.278	0.11 (-0.02 – 0.24)	0.098
CHILD GENDER, BOY	-0.17 (-0.44 – 0.11)	0.233	-0.07 (-0.38 – 0.25)	0.682
PARENTAL MENTAL WELL-BEING AT BASELINE[3]	-0.28 (-0.67 – 0.11)	0.162	0.23 (-0.31 – 0.77)	0.403
CHILD SLEEP TIME IN ACTIGRAPHY	0.03 (-0.23 – 0.28)	0.846	0.25 (-0.08 – 0.57)	0.131
CHILD SLEEP FRAGMENTATION INDEX IN ACTIGRAPHY AT BASELINE	0.00 (-0.02 – 0.02)	0.957	-0.00 (-0.03 – 0.02)	0.807
CHILD SLEEP EFFICIENCY INDEX IN ACTIGRAPHY AT BASELINE	-0.02 (-0.07 – 0.02)	0.337	-0.02 (-0.08 – 0.03)	0.431
PARENTAL INTERMEDIATE CHRONOTYPE[4]	0.05 (-0.35 – 0.44)	0.817	0.17 (-0.48 – 0.81)	0.611
PARENTAL MORNING CHRONOTYPE[4]	-0.25 (-0.64 – 0.15)	0.224	-0.08 (-0.73 – 0.57)	0.812
ADJUSTED R^2	0.396		0.302	

[1]Measured with the Jenkins sleep scale, [2]measured with the Children's ChronoType Questionnaire, [3]measured with the General Health Questionnaire 12, [4]measured with the modified Morningness-Eveningness Questionnaire. Modified from tables 4-5 in Study III.

Table 19. Step 4 of the linear regression analyses in Study III: The influence of the chronotype of the other parent added onto step 3.

PREDICTOR	MATERNAL		PATERNAL	
	Estimate (SD)	*P-value*	*Estimate (SD)*	*P-value*
PARENTAL SLEEP QUALITY AT BASELINE[1]	0.77 (0.56 -- 0.97)	**<0.001**	0.51 (0.33 -- 0.68)	**<0.001**
CHILD INTERMEDIATE CHRONOTYPE[2]	-0.46 (-0.89 -- -0.04)	**0.033**	-0.41 (-0.88 -- 0.05)	0.080
CHILD MORNING CHRONOTYPE[2]	-0.69 (-1.18 -- -0.19)	**0.007**	-0.67 (-1.18 -- -0.16)	**0.011**
CHILD AGE AT FOLLOW-UP	0.12 (-0.01 -- 0.24)	0.070	0.13 (-0.01 -- 0.26)	0.063
CHILD GENDER, BOY	-0.11 (-0.41 -- 0.19)	0.466	-0.07 (-0.38 -- 0.24)	0.656
PARENTAL GHQ-12 SCORE AT BASELINE[3]	-0.26 (-0.69 -- 0.17)	0.233	0.17 (-0.37 -- 0.71)	0.531
CHILD SLEEP TIME (H) IN ACTIGRAPHY AT BASELINE	0.00 (-0.30 -- 0.30)	0.998	0.27 (-0.05 -- 0.59)	0.100
CHILD SLEEP FRAGMENTATION INDEX IN ACTIGRAPHY AT BASELINE	-0.00 (-0.03 -- 0.02)	0.838	-0.00 (-0.03 -- 0.02)	0.849
CHILD SLEEP EFFICIENCY INDEX IN ACTIGRAPHY AT BASELINE	-0.03 (-0.08 -- 0.02)	0.206	-0.03 (-0.08 -- 0.03)	0.346
PARENTAL INTERMEDIATE CHRONOTYPE[4]	0.15 (-0.27 -- 0.58)	0.479	0.16 (-0.48 -- 0.81)	0.612
PARENTAL MORNING CHRONOTYPE[4]	-0.14 (-0.57 -- 0.28)	0.504	-0.07 (-0.72 -- 0.57)	0.821
INTERMEDIATE CHRONOTYPE[4] OF THE OTHER PARENT	0.29 (-0.35 -- 0.92)	0.370	-0.11 (-0.56 -- 0.33)	0.613
MORNING CHRONOTYPE[4] OF THE OTHER PARENT	0.13 (-0.51 -- 0.76)	0.697	-0.39 (-0.82 -- 0.03)	0.070
ADJUSTED R^2	0.392		0.320	

[1]Measured with the Jenkins sleep scale, [2]measured with the Children's ChronoType Questionnaire, [3]measured with the General Health Questionnaire 12, [4]measured with the modified Morningness-Eveningness Questionnaire. Modified from tables 4-5 in Study III.

6 Discussion

This thesis discovered that poor parental sleep is associated with the way the parent experiences the sleep of their child. Secondly, it was found that poor parental sleep does not predict later objectively measured child sleep problems, and, thirdly, that child eveningness was related to worse parental sleep at the follow-up. By improving poor parental and child sleep, the well-being of the family may be improved significantly. The findings are discussed in more detail in the following section.

6.1 Poor parental sleep and its associations with reported child sleep quality

The first finding of this thesis is that parental sleep quality associates with the way the parent reports on the sleep of their child. Poor parental sleep was associated with elevated levels of parent reported overall child sleep problems, disorders of excessive somnolence, disorders of initiating and maintaining sleep, and sleep-wake transition disorders. The study population only included children living with their biological parents.

The association between parental poor sleep quality and the child’s sleeping problems remained significant even when the objectively measured sleep quality was taken into account. Neither did a wide variety of background factors, such as parental education, child age, number of siblings, time of year, or family sleeping arrangements diminish the association. Parental sleep was not associated with the child's total 24-hour sleep time or the sleep efficiency in actigraphy in this study population.

The parental subjective sleep quality impacted to the same extent both the parental reports of all the studied child sleep problems and their different studied sub categories. This finding may reflect how poor sleep impacts the way a poorly sleeping person, here the parent, excessively recognises negative details (Gobin et al., 2015; Zohar et al., 2005) and sleep related cues (Marchetti et al., 2006; Spiegelhalder et al., 2008). Further, previous studies have shown that adults with insomnia tend to underestimate their amount of sleep compared to well-sleeping controls. (Manconi et al., 2010; Means et al., 2003) In light of the results of this study, it may be possible that this underestimation of amounts of sleep expands to the reports of poorly sleeping parents on the sleep of their child as well. However, it is possible that parental sleep problems associate with sleep problems of their children that were not detected in the actigraphy recording.

The main limitation of the study was comparing a qualitative measure, the Sleep Disturbance Scale for Children with a quantitative measure, child sleep measures in the actigraphy recording. The SDSC enquires about different sleep behaviours during the night in a time frame of the previous six months. In contrast, the actigraphy recording examines the values of sleep time and motoric restlessness during sleep. Its range of observation consists only of the week of the recording.

Actigraphy is not a recommended tool for diagnosing the sleep related behaviours that the SDSC examines. (Smith et al., 2018) However, many of the behaviours of the SDSC, including sleep walking, restless legs, and hypnic jerks, produce movement which may be recorded by the actigraph device. Further, the aim of the current study was not to diagnose these conditions, but to compare individuals within the study population. It is probable that on a group level, children with motorically restless sleep can be differentiated from calmly sleeping children also based on actigraphy data.

A Swiss based study later examined similar associations as seen here on school-aged children and came to identical conclusions: In the study, 191 children underwent in-home PSG. (Urfer-Maurer et al., 2017) Parents completed the questionnaires on the sleep of their child and their own tiredness. The study found out that, through the control of the child PSG findings, those parents who slept poorly experienced more sleeping problems in their children than did well-sleeping parents.

If parents overreported sleeping problems in their children, it could originate from the impacts of sleep loss on a person: i.e., the cognitive decline (Gobin et al., 2015; Zohar et al., 2005) and decrease in emotional capabilities (Sørengaard et al., 2021) that diminishes control over their emotions. This decline and decrease have been shown to result in more negative parenting, including parental behaviours that are authoritative, permissive or neglectful. (McQuillan et al., 2019, 2022) Earlier studies have found that parental reports of utilising means of negative parenting have a remarkable impact on parental perceptions of child negative behaviour compared to outside observer reports. (Moens et al., 2018) Parents who report using parenting practices classified as negative parenting, also perceive more negative behaviour in their child than an outside observer does. Whether negative parenting practices played a role in the findings of this study, was outside the scope of the study.

Child sleep studies regularly utilise sleep questionnaires to investigate the sleep of the child. For small children, these questionnaires are often completed by the caregiver, but seldom is the impact of the caregiver's own mood and sleep controlled for in the analyses. By using objective methods this bias could be avoided, but this would evidently lead to higher costs to execute the study and more inconvenience for the study attendants. This in turn could jeopardise the execution of large studies, which contribute new and much needed information on the sleep related interactions.

In studies using objective methods, often actigraphy, a discrepancy between the subjective reports of parents and the objective findings on child sleep has been found: compared to actigraphy, parents tend to overestimate the sleep efficiency of the child. (Lam et al., 2011; Werner et al., 2008) During the night, with the transition between the sleep cycles, sleep becomes more superficial at some points, and sometimes resulting in the sleeper's wakefulness. These short, normative states of wakefulness are missed by the parents, who themselves are often, and hopefully, asleep. However, if the parent is not asleep, these short awakenings maybe noticed and interpreted as something deviant.

Apparently, the sleeping arrangements also impact the degree to which parents notice these nightly behaviours: room-sharing parents notice more sleep related behaviours in their children but their reports on sleep related problems of their child are not more prevalent than those of parents sleeping in separate rooms to their children. (Covington et al., 2018) However, we do not know in which degree the sleeping arrangements affected the results in this study.

Additionally, in earlier studies evidence of different sorts of parent originated biases in parental reports has been well established: For instance, depressive parents have been shown to over-report the behavioural problems (Ringoot et al., 2015) and depressive symptoms (Hood, 2008) of their children. Further, it seems that the bias also varies between e.g. ethnic backgrounds of the respondent. (Li et al., 2021) For some clinical disorders, such as autism, attempts have been made to include items to recognise parental over and under reporting into the measures used when screening for the disorder. (Taylor et al., 2014) Thus far, child sleep disturbance diagnosis or research has not adopted this approach.

The findings of this study are of great significance to the clinical field, where the diagnosis of child sleep problems is usually based on parental reports due to the costs, availability, and laborious nature of objective tests. (Rintahaka, 2021) As a rule, parents are reliable reporters of child sleep (Gregory et al., 2011; Mazza et al., 2020) and child sleep problems do worsen the sleep of the parents. (Boergers et al., 2007) However, the findings of this study emphasise the large extent of the factors needed to be accounted for when examining a child with sleep problems. In fact, the sleeping problems of a child should be considered as the sleeping problems of the whole family. Because a major part of child sleep problems become chronic, (Simola et al., 2012; Williamson et al., 2019) parents need to be guided early on to find ways to care for their own sleep even if the sleep of their child cannot be improved. By taking care of themselves, the parents are taking care of their child and improving the quality of the upbringing they are offering their child.

6.1.1 Symptoms of daytime somnolence

Poorly sleeping parents also reported more daytime sleepiness in their children compared to the well sleeping parents. This daytime sleepiness that the parents acknowledged was not explained by the children sleeping less or sleeping more restless than the children of well-sleeping parents. Future studies may examine whether this finding was caused by poor parental sleep quality in fact associating with child daytime somnolence or whether it may be caused by an attentional (Marchetti et al., 2006) and interpretational (Gerlach et al., 2020) bias that poor sleepers express towards sleep related stimuli. Here the poorly sleeping parents on the other hand could notice sleep related behaviours better than well-sleeping parents; and also interpret different behaviours as sleep related to a higher degree than parents lacking problems with their sleep.

It is of note that the impression of many clinicians is that preschool children rarely exhibit symptoms of sleep loss or deprivation as somnolence, but rather as restlessness or irritability. Future studies may discover whether the symptoms of daytime somnolence, which the poorly sleeping parents reported in their offspring, are indeed for instance symptoms of conduct disorders. Hypothetically, these could be overrepresented in children of tired parents due to a deficient consistency and constructiveness in parenting caused by poor sleep.

6.1.2 Difficulties of initiating and maintaining sleep

For the sub score of difficulties of initiating and maintaining sleep, in addition to parental sleep quality, parental age was also a significant explanatory factor. The older the parent was, then the fewer of these problems were reported for their child.

The extent of the impact of sleep deprivation on a person varies between individuals as well as between age groups. (Philip et al., 2004; Taillard et al., 2021) Studies have shown that younger people are more prone to the effects of sleep deprivation on cognitive skills, e.g. reaction times while driving, (Adam et al., 2006) and it appears that their need for remedial sleep is larger than it is for older people. (Brendel et al., 1990) This age dependent impact of sleep deprivation on a person may explain why the younger parents in the study noticed more difficulties of initiating and maintaining sleep in their children, including waking up at night and having trouble falling asleep again, than the older parents did. In other words, the younger parents may have felt the disruptions in their much-needed nightly sleep as more burdensome than their older peers because of a larger need for catch-up sleep.

6.1.3 Sleep wake-transition disorders

Poorly sleeping parents reported more sleep-wake transition disorder symptoms in their children than did parents who slept well. These symptoms included different motorically restless behaviours during sleep and falling asleep. Parental sleep quality was examined with the Jenkins sleep scale. (Jenkins et al., 1988) Its four questions investigate the difficulty of falling asleep, waking up several times a night, trouble staying asleep and feeling tired after a normal night's sleep. Due to the nature of this measure, we could not differentiate whether the parents who over reported the sleep wake-transition disorders compared to actigraphy findings, did so because they were awake and noticed such nightly behaviours of their children that the well-sleeping parents did not, or whether the poor sleep caused a perception bias towards sleep related behaviours of their children. Future studies with simultaneous recordings of both parental and child sleep may shed more light on this phenomenon.

6.1.4 Parental depressive symptoms and the perceived child sleep quality

Without controlling for the parental sleep quality, parental depressive symptoms were associated with poor parental perceptions of child sleep. However, this association vanished when a control was implemented for parental sleep.

Earlier studies have shown that depressive symptoms negatively impact the way a person experiences their own sleep quality (Bowman et al., 2021; Orta et al., 2016) and increase parent reported child behaviour problems. (Gartstein et al., 2009; Madsen et al., 2020)

Sleep and depression seem to be intertwined: Insomnia may precede depression (Li et al., 2016) and depression may cause insomnia. (Asarnow & Manber, 2019) Studies have also shown that when the insomnia symptoms of depressive patients are appropriately treated, the symptoms of depression are also more likely to be alleviated. (Asarnow & Manber, 2019; Gebara et al., 2018) It seems that in the study population of this thesis, the effect of depressive symptoms on parental perceptions of child sleep quality originated from parental sleep quality, which was the determining explanatory factor.

6.2 Parental sleep quality and later child sleep problems

Parental sleeping problems did not predict objectively measured child sleeping problems at the one-year follow-up. In line with previous research, (Iglowstein et al., 2003; Price et al., 2014) child age associated with an improving sleep quality: it decreased sleep onset latency and sleep fragmentation, and increased sleep efficiency. Additionally, child age was associated with shorter sleep time as a part of the normative development of children's sleep. Poor paternal sleep quality at baseline associated with a decrease in child sleep efficiency in follow-up.

6.2.1 The impact of adoption status

Being adopted was associated with a longer time in bed and total sleep time, and a shorter sleep onset latency in the actigraphy. These results, from the same study population as the population of this thesis, have been published earlier by Heikkilä et al. 2022. Internationally adopted children undergo many developmental catch-up processes after arriving in a home with sufficient nurturing and nutrition. Heikkilä et al. speculate that the difference in these sleep domains between relatively recently internationally adopted children and their biological controls may be explained by the increased need for sleep that these processes require.

6.2.2 Child gender

When examining both maternal and paternal background factors, being a boy associated with longer sleep onset latency in the objective findings. An increase of one point in the parental Jenkins sleep scale, lengthened the sleep onset latency of male offspring by 3-4 minutes. In previous studies on child sleep, gender differences of sleep onset latency of pre-school children have not been prevalent. However, in an Australian study on the impact of sleep hygiene on the sleep of four- to six-year-olds, boys with an inconsistent sleep time routine had more parent reported sleep problems than girls with the same inconsistencies. (Uebergang et al., 2017) Whether this explains the finding of the current study, remains unclear for now as information on sleep hygiene and sleep time routines was missing in this study.

6.2.3 Paternal sleep

Poor paternal sleep quality at baseline was associated with decreased child sleep efficiency at the follow-up. Earlier studies have shown that child sleep problems are associated with paternal stress and fathers of children with sleep problems rating their children as fussier than the fathers of well-sleeping children. (Millikovsky-Ayalon et al., 2015) Additionally, in a study setting and assessed by an outside observer, fathers of children with sleep problems were less involved in their interaction with their child than fathers of well-sleeping children. (Millikovsky-Ayalon et al., 2015) Whether these earlier findings could with time impact child sleep quality remains to be established in further studies. However, the association between paternal sleep problems at baseline and lower child sleep efficiency at the follow-up was not evidenced for the other sleep parameters, such as total sleep time or time in bed. Therefore, the finding may be caused by chance but this will need further studies in order to be clarified.

6.2.4 Other factors affecting child sleep

Previous studies have shown that the poor sleep hygiene of the parent is associated with poor child sleep hygiene and parental reports of child sleep problems. (Chehri et al., 2022) In the present, study we did not enquire about the sleep hygiene or sleep time routines of the participants. Another study found that parental knowledge of age-appropriate sleep amounts for children predicted longer sleep and earlier sleep times. (McDowall et al., 2017) Based on these findings, the question arises of whether a number of the sleep disturbances in the population are merely due to not giving sleep a high value and thereby inadvertently exceeding the bedtimes and neglecting sleep time routines both for the parent and their child. To take this further, will these parental habits unintentionally transfer to their children weakening the children's sleep quality and sleep related practices?

Additionally, from earlier studies we know that the poor sleep of a person, here the parent, leads to a variety of emotional and cognitive impairments. (Killgore et al., 2006; Minkel et al., 2012; Sørengaard et al., 2021; van der Helm et al., 2010) These impairments to a certain degree may influence the atmosphere at home (Curotto et al., 2022). They may impact the parent-child relationship, which has shown to associate with child sleep quality, (Bordeleau et al., 2012) as has the atmosphere at home. (Kelly & El-Sheikh, 2013) In this study, these interactions did not lead to child sleeping problems at the one-year follow-up, but longer follow-up studies are needed to ensure the validity of this finding in the long term.

6.3 Child chronotype and later parental sleep

Child morning chronotype was shown to associate with better parental sleep in the follow-up. Both mothers and fathers of morning type children experienced an improvement of sleep quality between the two study points compared to parents of evening type children. The same interaction was found in the sleep of mothers of intermediate type children. This latter finding could not be evidenced for paternal sleep. Being adopted did not influence this finding.

In addition to the association of child eveningness seen in this study, that is the deteriorating association with parental sleep quality compared to child morningness, previous studies have shown that child eveningness associates with e.g. childhood depression, (Haraden et al., 2017) aggressiveness (Schlarb et al., 2014)and behavioural problems. (Doi et al., 2015)

The impact of a person's eveningness is not limited to the person themselves: Maternal eveningness associates with infant sleep problems. (Morales-Muñoz et al., 2019) In addition, in a family where the other members are evening type, morningness of one member associates with somnolence and increased caffeine intake of the morning type individual. (Pereira-Morales et al., 2019) A large survey on 18,000 adults recognised that adults of moderate evening-type reported their mothers having a diagnosis of depression more often than morning type study attendees. (Merikanto & Partonen, 2021)

The chronotype of a person seems to be quite stable (Druiven et al., 2020; Kuula et al., 2018) but some changes do occur during the development and aging. (Randler et al., 2017) Moreover, the surroundings do impact the diurnal phenotype.(Leocadio-Miguel et al., 2017; Leonhard & Randler, 2009; Shawa et al., 2018)

The intrinsic diurnal rhythm of evening type children is delayed compared to morning type children, which makes them more alert in the evening and feeling less tired. (Roenneberg et al., 2003, 2019) Eveningness has also been associated with sleep problems, (Jafar et al., 2017; Ksinan Jiskrova et al., 2019) which may explain why evening type children encounter more conflicts with their parents at bedtime than morning type children. (Zimmermann, 2016). Simultaneously, actigraphy based studies have shown that a high-level of cognitive activity before sleep is associated with poorer subjective sleep quality compared to objective findings. (Herbert et al., 2017) From the viewpoint of the parent, these conflicts in the evening may raise the parent's activity levels in such a way that the subjective sleep quality is impaired.

As stated, child eveningness is associated with child sleep problems. In the current study child sleep parameters in actigraphy were also analysed and these did not diminish the association between child chronotype and parental sleep at the follow-up. In other words, in this study, the chronotype of the child was associated with parental sleep in follow-up regardless of the child having sleep problems or not. Even if the child slept well, if the child was of evening type, their diurnal preference was associated with poorer parental sleep quality in follow-up compared to morning type children. In this study we examined the parental sleep with a subjective measure, a questionnaire. Further studies are needed to clarify whether the poor parental sleep quality the parents report at follow-up is also objectively recognisable.

For both parents, sleep quality at baseline was associated with sleep quality at the follow-up. This finding is explained by the prolonged course of sleep problems. (Morphy et al., 2007) Of those individuals with clinically diagnosed insomnia, 70% show symptoms of insomnia at one year follow-up and 50% at three years.

6.3.1 Difference in maternal and paternal outcomes

Studies from abroad have indicated that the impact of child sleep on the sleep of opposite-sex parents is fairly equal when analysed objectively. (Härdelin et al., 2021) According to some studies, women have a larger subjective need for sleep and are influenced by sleep restrictions more than men. (Mallampalli & Carter, 2014) This thesis, furthermore, recognised that child intermediate chronotype predicted maternal sleep problems at the follow-up compared to the morning type of the child. This association was not evident for paternal sleep problems.

The discrepancy may be explained by the longer preferred sleep time of women. (Polo-Kantola et al., 2016) In addition, previous studies have, among other things, shown that maternal, but not paternal, evening chronotype is associated with child sleep problems at two years of age. ((Morales-Muñoz et al., 2019) Furthermore, maternal and child sleep timings have been shown to adhere more to each other than to that of the partner or father. (Kalak et al., 2012; Kouros & El-Sheikh, 2017; Leonhard & Randler, 2009) In this population, maternal and child sleep may have been linked to a higher degree than those of the child and father.

6.3.2 Impact of the chronotype of the other parent or the parents themselves

Prior studies have shown that evening type people experience more sleep problems than morning type individuals. (Roenneberg et al., 2019) Further it seems that the chronotypes of the other family members impact the diurnal rhythm and sleepiness of a person. (Kouros & El-Sheikh, 2017; Pereira-Morales et al., 2019)

In this study however, neither the chronotype of the person themselves nor the chronotype of the other parent was found to associate with changes in parental sleep quality at the follow-up. This finding was controlled for by the parental sleep quality at baseline, which may explain the lack of association. If the level of deterioration of sleep quality of the evening type individuals was constant between baseline and follow-up compared to morning type individuals, the linear regression analyses utilised might not show the chronotype as being a further risk factor for parental sleep quality at follow-up. Hence, the impact of chronotype on the sleep of the parent might have already been evident at the baseline.

For both mothers and fathers, the chronotype of the other parent was not associated with sleep problems at the follow-up. Previous studies have shown that maternal and child diurnal rhythm are more strongly linked than the rhythms between parents. (Leonhard & Randler, 2009) The lack of association may reflect how the parental responsibilities in Finland, as in the rest of the Nordic countries, are now being divided ever more evenly between the parents. (Eydal et al., 2015)

Therefore the child chronotype was the main contributing factor in parental sleep quality, regardless of the chronotype of either of the parents.

6.3.3 Alleviating the effects of eveningness

To alleviate the negative impact of eveningness on either the individual's health or their family's health, treatment of this delayed circadian rhythm includes correctly timed therapy with bright light in the morning and melatonin in the evening. (Auger et al., 2015; Dautovich et al., 2019; Roenneberg et al., 2019) For children, the focus of the treatment lies in parental guidance. In milder forms especially, the primary treatment is to ensure consistent and age-appropriate sleep times, which may be enhanced with the dosage of melatonin or bright light. (Rintahaka, 2021)

Studies on the treatment of eveningness have shown that advancing the daily rhythm may be laborious and the impact ceases if the therapy is discontinued. (Arns et al., 2021; Gomes et al., 2021; Richardson et al., 2018) However, when the sleep-wake rhythm of a person is advanced successfully the risk of adult depression becoming chronic is lowered. (Chan et al., 2022) Moreover, the parental knowledge of healthy sleep habits has been associated with earlier and more consistent bedtimes for the child, (McDowall et al., 2017) which is why spreading information also on the effects of eveningness is likely to benefit the sleep of the paediatric population.

Studies have also shown that the daytime somnolence and insomnia symptoms that are associated with the evening chronotype, may be alleviated when the person's daily rhythm, e.g., working hours, are adjusted to the person's intrinsic rhythm. (Salfi et al., 2022) In some countries, school start times have been moved later to tackle the problem of school children's sleep deficit and daytime somnolence. A Cochrane review concluded that some studies have shown that the intervention has been successful, but studies without this response have been published and the intervention warrants more research. (Marx et al., 2017)

6.3.4 Heritability of chronotypes

The chronotype of a person is partially hereditable. (Kalmbach et al., 2017; Maukonen et al., 2020) In our study, the results were unchanged when examining the influence of the child being internationally adopted or not. This seems feasible as the child staying up late and resisting sleep onset may impact both adoptive parents and biological parents in the same fashion.

Quite surprisingly, maternal and child chronotypes associated only weakly and in a negative relationship (in preliminary analyses $r = -.22$, $p = 0.02$) and no association was found between paternal and child chronotypes ($p = 0.62$). Thus, in this study the hereditability of chronotypes was not evident.

6.4 Consequences of poor parental sleep

As discussed earlier, how the parent sleeps impacts the child in many ways. It may impact the quality of parental interactions (McQuillan et al., 2019, 2022) and the atmosphere in the home. (Curotto et al., 2022) Poor sleep is associated with difficulties with emotion control (Tempesta et al., 2020) and it impairs the ability to recognise emotions. (van der Helm et al., 2010)

Further, poor parental sleep may also have implications on the everyday life of the family in concrete ways: poor adult sleep has been associated with job absenteeism, (Lallukka et al., 2014) decelerated career progression, and sick leave. (Kucharczyk et al., 2012) These may lead to a weakening economic situation for the family. Moreover, different accidents, (Tefft, 2018) and cardiovascular (Laugsand et al., 2011; Tobaldini et al., 2017) and psychiatric (Baglioni et al., 2011) morbidities that increase through sleep problems, may impact both the economic situation and the well-being of the family and its members.

6.5 Methodological considerations and limitations

6.5.1 The inclusion of the internationally adopted children

The strengths of this study include the population consisting of both children living with their biological families as well as internationally adopted children. Quite surprisingly, most of the associations seen did not alter with the inclusion or exclusion of the internationally adopted children.

The results of the sleep parameters of the internationally adopted children have been published by Heikkilä et al. 2022. They discovered that the internationally adopted children had longer sleep times and time in bed than children living with their biological families, but that these differences decreased during the one-year follow-up. They also discuss the fact that although the internationally adopted children are at a high risk for sleeping troubles based on the possible traumatic backgrounds and histories of maltreatment, many of them come from orphanages where they have been forced to develop self-soothing skills at bedtimes, as adult support and assistance may have been scarce. Moreover, the process of adoption often leads to rapid catch-up processes when the surroundings of the child become more nurturing and these processes may require more sleep.

6.5.2 Sleeping arrangements and parental employment

In comparison with an international study with 3000 children conducted in Asia, Europe, North America and Australia, the proportion of co-sleepers in this study seemed to be similar. (Mindell et al., 2013) In predominantly Caucasian countries the incidence of room and/or bed sharing varied between 19-24%. In this study, 25% of the two- to six-year-old children slept in the same room as their parents. Room-sharing may also increase the degree to which parents recognize different bedtime behaviours of their children during the night. (Dyer et al., 2007) When the results were controlled for room sharing in Study I, there were no changes in the findings. Due to the already large number of background factors in Studies II and II, we did not analyse whether co-sleeping impacted the associations of the study. However, for clinicians, regardless of the family sleeping arrangements, the study is a reminder to take the parental sleep quality into account and as a target for treatment when treating child sleep problems.

The same applies to parental employment: In Study I parental employment did not impact the study results, but this association was not analysed in studies II and III. However, at the baseline for the families of the non-adopted group, the unemployment rate of the parents in the study was equal to that of the Finnish population at the time of the study, 8.7%. (Official Statistics of Finland, 2015) Further, the population consisted of mainly Caucasian well-educated parents, which may hinder the generalisation of the results.

6.5.3 The duration of the scope of the sleep measures

In Studies I, II and III, parental sleep was analysed subjectively by the Jenkins sleep questionnaire. The questionnaire enquires about sleep problems during the previous 4 weeks. The actigraphy recording lasted a week, and in Study I, the Sleep Disturbance Scale for Children that the parents completed, asked about symptoms during the previous 6 months. Thus, the duration of the scopes of the measurements do not completely concur. However, all the measurements have been proven valid within their purpose (Antczak et al., 2021; Bruni et al., 1996; Jenkins et al., 1988; Romeo et al., 2013) and the period that the questionnaires examine includes the actigraphy recording. As stated, we did not specifically or in written form ask the families whether the sleep and sleeping conditions of the study week were representative of their normal routines. At the retrieval of the actigraph device and the questionnaires the families were able to report any disruptions or problems with the study protocol.

Nonetheless, we do not know whether the study population included children who, for one reason or another, slept better than normal during the study. We did not ask the parents whether they experienced the child's sleep during the study week being representative of the child's normal sleep. It is possible that during the participation in the sleep study, the parents paid particular attention to child sleep routines which led to the child sleeping better during the week of the study than normally. This week of better sleep could have been captured on the actigraphy recording, but the parental tiredness from the earlier weeks of poor child sleep had not yet dispersed.

Further we did not control for many aspects impacting child sleep such as parenting styles, screen time, parental illnesses and sleep related cognitions.

6.5.4 Measures of parental mental health

Poor sleep and poor mental health are strongly associated. (Gebara et al., 2018; Gregory et al., 2009; Li et al., 2016) Thus, in Studies I and III parental mental health was analysed as a background factor. To evaluate this, the GHQ-12 questionnaire was used. Its second question enquires about lost sleep due to worry. In Study I this question was omitted to avoid a possible overlap. In Study III the item was not omitted but even with this possible overlap in the measurements, the GHQ-12 scores of the parents did not alter the findings significantly.

Study II, which found that parental sleep problems do not predict increasing levels of child sleep problems at a one-year follow-up, did not consider parental mental well-being as a background factor. Previous studies have discovered that poor parental mental health does predict poor child sleep, in addition to the impact of the consequences of poor sleep on cognitive and emotional abilities and thereby on parenthood. These mechanisms could potentially also impact child sleep, which somewhat unexpectedly could not be seen in the results of Study II. Further studies need to confirm whether the impact of poor parental sleep on the sleep of the child emerges in longer follow-ups.

6.5.5 Comparing parental reports of child sleep with actigraphy recordings

To enable the study setting of Study I, the sleep of the children was examined both subjectively through parental reports and objectively with an actigraph. The extent of the actigraph recordings was sufficient as 98% of the children had data from 5 or more days of actigraphy and the remaining 2% produced four days of data. According to a recent study to validate the GeneActiv actigraph for sleep research in children by Antczak et al 2021, 3-5 days is needed to gain reliable information on sleep parameters.

As discussed earlier, the main limitation of the study is using child sleep parameters from actigraphy parallel with a more qualitative method, the Sleep Disturbance Scale, where parents answered on questions on different kinds of child sleep behaviours and problems. The total score of the SDSC may seem artificial as it sums up all the different sleep problems from different sleep domains, including parasomnias, sleep hyperhidrosis, and sleep wake-transition disorders. However, the aim of the current study was not to obtain a diagnosis or compare children with specific diagnosis with each other. We aimed at gathering information of parental perceptions on the sleep of their children. Therefore, it was considered sufficient to gain this information through the questionnaire in a general manner.

In this study, similar to the SDSC, the actigraphy recording was not used to diagnose child sleep problems but to evaluate the restlessness and sleep time of children. Previous studies have shown that poor child sleep impacts parental sleep in a deteriorating manner. (Varma et al., 2020) This study aimed to examine whether in addition to this association, the extent to which the parent experiences their sleep as being poor, impacts the way they perceive the sleep of their child. The hypothesis was that parents who slept poorly, regardless of the reason for poor sleep, experienced the sleep of their children as poorer. Here the actigraphy recording was to compare the sleep amounts and restlessness between the children of well-sleeping and poorly sleeping parents. The actigraphy recording has many limitations which have been discussed in detail earlier. The limitations of the measure impacted all the children equally, which is why the method was considered valid in between-group comparisons of child sleep parameters.

Further, a previous study examining the association between actigraphy and a qualitative questionnaire on parental perceptions of child sleep, the Children's Sleep Habits Questionnaire, (Owens et al., 2001) on school age children found that the total 24-hour sleep time in actigraphy associated with parental reports of parasomnias, bedtime resistance and sleep onset delay. (Holley et al., 2009) In that study, daytime sleepiness did not correlate with any actigraphy parameters.

Different actigraphy parameters were utilized in the studies. As actigraphy records motion, and the different actigraphy parameters are derived from the same data, these parameters may be closely correlated. Using a number of different actigraphy parameters in the same model raises the possibility of multicollinearity, which may impact the association between individual independent variables (that are highly correlated) and outcomes. Thus, multicollinearity may make it more difficult to estimate the relationship between each of the independent variables and the dependent variable. The age of the parents of the study were nationally representative: According to a written communication from the official statistics of Finland, the ages of the study parents corresponded to the mean ages of mothers and fathers of Finnish four-year-olds, which were 34 years and 37 years respectively.

6.5.6 Chronotype

A limitation of Study III was that the chronotypes of the parents and the children were evaluated at the follow-up, not the baseline. One of the goals of the study regarding clinical medicine was to find warning signals for the clinician which would allow them to be able to distinguish better those families in need of sleep related interventions. The mean follow-up time was 1 year and 3 months. Considering this, the later application of the chronotype measures was not likely to impact the results. Although many things impact the actual chronotype of a person, and the chronotype is thought to be able to change over time, (Roenneberg et al., 2019) the chronotype has still been shown to stay unchanged during periods of several years. (Druiven et al., 2020; Haraden et al., 2017)

Further, the chronotypes were evaluated based on questionnaires. Chronotype measures can also be derived from actigraphy data. As the children living with their biological families were recruited to the study from day-care centres, we anticipated that the cosine peak values for these children would be influenced by the common daily programs (children playing outside and resting approximately simultaneously) at the day-care centres. The actigraphy parameters could have been used to evaluate the social jetlag of the children by comparing free-days and days at the day-care but this was beyond the scope of the study. Further, in the clinical field, the assessment of child and parent eveningness relies on the reports of the individuals or their parents. Thus, we found it practical to utilise measures of the perceived chronotype.

Measured by the questionnaires and categorised by the chronotype cut-offs set by the researchers, the chronotypes of the children were distributed quite normally, as expected. (Werner et al., 2009) However, the number of parents with an evening chronotype was lower than anticipated. (Roenneberg et al., 2019) The explanation of this finding remains unclear. It seems that no studies have examined whether an individual's chronotype advances after having a child. Nonetheless this advancement could be plausible, as the environment shapes the chronotype of an individual to some extent. (Roenneberg et al., 2003, 2019; Wittmann et al., 2006)

6.5.7 Considerations of the follow-up studies

In addition to children living with their biological families, internationally adopted children were included in Study II on parental sleep as a predictor of later child sleep problems and Study III on child chronotype as a predictor of later parental sleep problems, this was in order to exclude possible genetic associations of the sleep related phenomena. This meant, however, that the mean ages of the parents rose past the national average to 38 years for mothers and 40 years for fathers. This is a result from the fact that adoptive parents are often older than their counterparts with biological children. The adoptive process often lasts several years from the decision of wanting to adopt to meeting the adoptive child. Moreover, this process may be preceded by unsuccessful attempts to become biological parents and possibly includes medical treatments.

Due to the limited number of background factors, co-sleeping or parental employment rate were not included in Studies II and III. Moreover, parental sleep was only subjectively analysed. As stated before, future studies may elucidate whether the associations of poor subjective parental sleep and child sleep quality at a one-year follow-up, and child chronotype and the subjective sleep quality of the parent, also exists for the objective parental sleep parameters.

6.6 Clinical implications and future considerations

This thesis found that poorly sleeping parents reported more sleeping problems in their children than well-sleeping parents compared to the child sleep parameters recorded in actigraphy. This study does not allow deductions on causal relationship of the finding. It is possible that the children of the poorly sleeping parents indeed had more sleep problems than children of well-sleeping parents, but these sleep problems were, for one reason or another, not detected by the actigraph recording. On the other hand, it is also possible that the poor sleep experienced by the parents lead to an overestimation of sleep problems of their children. Regardless of causality, this finding highlights the importance of considering many different aspects when treating a child with sleep problems. These include both child and parental attributes, and attributes of the family as a whole.

Additionally, a large portion of sleep problems of both children and adults tend to persist. (Falch-Madsen et al., 2020; Morphy et al., 2007; Simola et al., 2012) Therefore, parents should be instructed early on to find ways of assuring adequate sleep for themselves even if their nightly sleep is compromised.

As the parental sleep was examined only by a subjective measure, future studies may clarify this finding by analysing the parental sleep with objective measures. Executing simultaneous recordings of child and parental sleep could help to decipher whether the nightly behaviours that the poorly sleeping parents reported for their offspring were truly noticed by the parents because the parents were already more often awake at night. The higher rate of reports can also arise from an attention bias due to the sleepiness of the parent.

Further studies may also investigate whether the symptoms of daytime somnolence that the tired parents reported for their children, actually were symptoms of disorders of conduct due to the lack of consistency arising from parental sleepiness and poor sleep without the children themselves suffering from sleep deprivation.

The second main finding of this thesis was that poor parental sleep did not increase child sleep problems in the follow-up. This finding may ease the mind of poorly sleeping parents. Apparently, their sleep problems do not impact their performance as parents and the relationships within the family to such a degree that it would lead to a deterioration of the child's sleep. However, the length of the follow-up was only a little over a year and longer follow-up studies are needed to confirm this finding. Previous studies have found several negative consequences of poor parental sleep on the parental functioning, which could influence the interactions within the family in such a way that the child's sleep could be endangered.

Thirdly, the thesis found that the eveningness of a child is associated with later parental sleep problems. In previous studies, child eveningness has already been linked to a variety of different negative outcomes. However, changing the diurnal rhythm of an evening type person is laborious, and needs constant vigilance, or otherwise the rhythm tends to return to the previous one. (Richardson et al., 2018) As stated before, the advancing of the diurnal rhythm is productive and bears many positive consequences on the health and well-being of the individual themself and their surroundings.

In the current study, parental sleep was examined by subjective reports. Future studies may show whether the findings on subjective poorer parental sleep can be truly observed in objective parameters of sleep quality, or whether child eveningness increases the parent's tiredness and feelings of fatigue.

Knowing that child eveningness decreases parental sleep quality later on may encourage parents and professionals to be more persistent in finding ways to enhance the child's ability to fall asleep at a reasonable hour. In addition, this once more underlines how child and parent sleep are entwined and cannot be examined alone without giving consideration to both.

The studies of this thesis position poor parental sleep into a clearer context within the dynamics of sleep in the family. Previous studies have shown how poor parental sleep, as with sleep in general, has major implications on the well-being of a person and those closest to them. In the field of paediatric sleep, parental sleep has often been neglected thereby failing to benefit from possible targets for effective interventions on the quality of life of the whole family. In the future, child sleep will hopefully be evaluated through a wider perspective, one that also includes parental attributes.

7 Conclusions

The main findings of this thesis can be summarised as follows:

1. Parental sleep quality impacted the way parents perceive the sleep of their child. Compared to well-rested parents, parents with poor sleep quality report increased amounts of overall child sleep problems, and symptoms of disorders of initiating and maintaining sleep, problems of daytime tiredness, and sleep-wake transition disorders in their children, such as head banging, restless legs and twitching during falling asleep and being asleep. This difference remained even when objectively measured sleep quality was taken into account.
2. Parental sleep problems did not predict later poor child sleep in a follow-up at one year. Child sleep at the follow-up was positively associated with child age. Boys seem to have a longer sleep onset latency in the actigraphy at the follow-up than girls.
3. Child morningness was related to less parental sleep problems at the one-year follow-up. Child intermediate chronotype was related to less maternal, but not paternal, sleep problems at the one-year follow-up.

These findings place parental and child sleep into a clearer context by expanding on the knowledge of the interactions between them and emphasising the importance of assessing both in examinations of particular problems.

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