CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Sociological Studies

Department of Sociology

Doctoral Dissertation

2024 **Michaela Prokeš**

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Sleep in the Context of Quality of Life

Doctoral Dissertation

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Abstract

The central focus of my dissertation thesis is sleep in the context of quality of life. The significance and value of a good night's sleep to our well-being is often underestimated. Although partially determined by genetics, sleep is also strongly determined by environmental and social factors. Much of the research in this area, however, limits itself to studies with biomedical approaches, and the sociological aspects of sleep are rarely investigated. The dissertation aims to bridge this knowledge gap, discussing sleep in the context of quality of life and applying a variety of analytical methods on data collected from a Czech population sample to study how sleep affects and is affected by quality of life.

Motivated by a lack of research on the longitudinal effects of sleep and well-being, the dissertation includes a research article (Chapter 3) on the long-term effects of changes in sleep duration, sleep quality and social jetlag (the discrepancy between biological time and social times) on quality of life (satisfaction with life, happiness, work stress, subjective health and well-being). A second article investigates social jetlag and its links to work and family (Chapter 4). A third article studies sleep in the context of family types and the effect of parenthood on sleep duration and social jetlag, and also compares sleep quality in childless individuals to parents with children of different ages (Chapter 5).

The findings in my academic studies suggest that sleep quality is the most important sleep variable of all and that both sleep duration and social jetlag tend to remain relatively stable over time. Social jetlag also appears to be more closely linked to work environments rather than family: self-employed and professional classes are less likely to suffer from social jetlag whereas lower occupational classes have higher levels of social jetlag, indicating significant misalignment between workdays and free days. As a follow-up to the study on family types, a comparison of childless individuals and parents indicates that

these two group share similarities in sleep schedules and experience equivalently poor sleep quality. Differences between gender, however, reveal that mothers are especially sleep deprived on free days and that caring for children is equivalent to working seven days a week instead of an average five days a week.

Foreword

The dissertation is cumulative, consisting of several articles written during my PhD studies. Two articles have already been published (Chapter 3: 'Better Sleep, Better Life? Testing the Role of Sleep in Quality of Life.'; and Chapter 4: 'Social Jetlag: Work and Family Correlates.') and one is submitted to an academic journal (Chapter 5: 'Sleep Practices among Parents and Childless Individuals.').

The following articles have already been published:

Kudrnáčová, Michaela and Aleš Kudrnáč. 2023. "Better Sleep, Better Life? Testing the Role of Sleep in Quality of Life." *PloS one* 18(3): 1-18.

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Keywords

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Co-authors' statements

Since two of the articles (chapter 3 and 4) incorporated into this thesis are co-authored, authorship statements are included in the dissertation.

I, Dana Hamplová, hereby confirm I contributed approximately 50% to the writing of the text "Social jetlag: work and family correlates".

Dana Hamplová

I, Aleš Kudrnáč, hereby confirm I contributed approximately 50% to the writing of the text "Better sleep, better life? Testing the role of sleep in quality of life".

Aleš Kudrnáč

Declaration

1. I declare that I wrote the presented dissertation independently (except for Chapters 3 and 4, which were co-authored studies) and used only the sources and literature mentioned.
2. I declare that the work has not been used to obtain any other academic degree.
3. I agree to release the dissertation so that it may be available for study and research purposes.

In Prague

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1. Introduction to the dissertation subject

Sleep deprivation is so prevalent that it is often referred to as an epidemic (National Sleep Foundation 2014). A recent global survey (Royal Philips 2020) showed that less than half (49%) of people were somewhat or completely satisfied with their sleep quality and approximately one third (33%) reported anxiety and stress as the most limiting factor preventing good sleep. Significantly, compared to previous surveys, fewer people were also willing to act on improving their sleep. These results indicate the urgency to discuss sleep from a sociological point of view and emphasize its link to social factors and overall quality of life.

Traditionally, social sciences study society, specifically social determinants and consequences. However, in recent years, the intersection of social and biological dimensions has drawn increasing attention. The dissertation explores factors in relation to sleep patterns, inquiring particularly into the misalignment between biological and social rhythms (social jetlag) and its effect on quality of life.

The idea to research sleep quality from a sociological perspective was conceived from the TA CR project *The Cumulative Effects of Social Disadvantage on Health and Quality of Life* (2019–2022) led by Prof. Dana Hamplová at the Institute of Sociology of the Czech Academy of Sciences in cooperation with the Laboratory of Biological Rhythms of the Institute of Physiology. The project's aim was to evaluate the role of socioeconomic conditions on quality of life and health from a multidisciplinary (sociological and epidemiological) perspective. The project included an ongoing Czech household panel survey (CHPS) which recorded data on sleep. I found this very interesting, because the idea of analysing sleep from a social sciences perspective is novel. The project inspired me to pursue a career as a PhD researcher at Charles University and to devote myself to studying sleep in the context of quality of life.

The introduction to the dissertation topic summarizes the research topic and introduces the terms and concepts of circadian preferences and social jetlag. It follows with a discussion of the existence of sociological perspectives on sleep and general importance of sleep. The introduction then clarifies the Czech context and its analytical contribution to the general discussion.

1.1. Definitions: circadian preference and sleep patterns

Sleep is versatile. All animal species known to mankind engage in sleep or sleep-like rest. It is a fascinating phenomenon combining two important and inseparable areas of human life: biological and social. Every biological function of the body benefits by a good night's sleep: it is essential for the regeneration and maintenance of health. During sleep, the body prepares for the new day. At the same time, sleep also has an impact on the cognitive functions, influences emotional state of mind, and ability to interact with other people.

1.1.1. Circadian preferences

Society can be observed from a multitude of perspectives: we can group it according to gender, ethnicity or elite status. We can also classify individuals according to sleep, specifically their inclinations to sleep or be active at certain times of day.

This inclination is called circadian preference (also known as chronotype) and determined by the preferences for times of day for processes such as sleep and waking. This pattern is also called the circadian rhythm and has a period of approximately 24 hours. Determining an individual's circadian preference enables us to better understand the body's functioning and the effects between different biological processes and social aspects in our daily lives. The two main terms to describe circadian preferences are 'morningness' and 'eveningness' (individuals are also more colloquially referred to as 'larks' or 'owls' according to whether the peak of their activity occurs during the day or night), and each is represented by roughly 20% of the population. A third, intermediate circadian preference also exists and is the most common (Adan et al. 2010). Although these classifications are not ideal (the limitations are discussed in Chapter 2.2.2), circadian preferences in the academic literature are often described according to these definitions, and for simplicity and familiarization, the introduction here applies the same definitions.

It is generally accepted that circadian preference is affected mainly by age (Adan et al. 2012; Duarte et al. 2014; Paine, Gander, and Travier 2006). Pre-school children are inclined towards morningness, while teenagers tend to shift towards eveningness (Caci et al. 2005; Randler, Bilger, and Díaz-Morales 2009). At around 17 to 20 years of age, the circadian preferences usually revert to morningness (Díaz-Morales and Randler 2008; Jankowski 2015; Randler and Truc 2014; Roenneberg et al. 2004). The likelihood of being a morning circadian preference also increases with age (Jankowski 2015; Paine et al. 2006; Taillard et al. 2004).

Significant differences also exist between sexes. Women are slightly more morning-oriented than men (Adan et al. 2012; Adan and Natale 2002; Bailey and Silver 2014; Duffy et al. 2011; Fabbian et al. 2016), although the difference appears to be rather small, and some authors suggest the effect of latent variables (Randler 2007) or mention that observations are based on insufficiently large data samples (Duffy et al. 2011). The evening circadian preference is generally linked to unhealthy habits (Fabbian et al. 2016) and thus greater susceptibility to a range of health problems, which includes diabetes and psychological, neurological, respiratory and gastrointestinal disorders (Knutson and von Schantz 2018; Merikanto et al. 2015). It also an indicator for depression, possibly resulting from sleeping problems, which are exhibited more by evening types (Jankowski 2016; Levandovski et al. 2011a; Merikanto et al. 2013; Urrila et al. 2012).

In addition to the various determinants of sleep, which are mostly biological in nature, we cannot ignore the links with social characteristics. A number of studies have linked the circadian rhythm to psychological conditions and suicide. Evening types are more likely to display psychological illnesses such as depression (Antypa et al. 2016; Gau et al. 2007; Merikanto et al. 2013) and demonstrate greater suicidal ideation than morning types (Gau et al. 2007). Evening types are also more impulsive, engage more frequently in suicidal thoughts, and use more fatal suicide methods than morning types (Selvi et al. 2011). Depression has been shown to play a mediating role in the relationship between circadian preference and suicidal ideation (Park et al. 2018).

Research conducted on university students in Denmark (Aledavood, Lehmann, and Saramäki 2018) suggests that evening types have larger personal networks than morning types, and evening-oriented people have more central roles in their social networks. However, some evidence indicates that the preference for eveningness in adolescents is associated with lower social functioning (e.g., in closeness of friendships, intimate relationships, engagement in social activities, etc.) (Lunsford-Avery, Kollins, and Mittal 2019). Sleep deprivation and poor sleep quality have also been linked to poorer socio-emotional cognition and social functioning, regardless of the circadian preference (Beattie et al. 2015). On a positive note, higher intelligence and performance also appear to be related to eveningness (Randler 2017).

In relation to quality of life and well-being, morning types are more often inclined to report higher levels of life satisfaction (Díaz-Morales et al. 2013; Jankowski 2015), overall better mood (Jankowski 2015) and enhanced well-being (Howell et al. 2008;

Randler 2008), while evening types report disadvantageous characteristics in quality of life (Tzischinsky and Shochat 2011).

Although the differences between circadian preference types are very interesting, the drawback to this comparison is that it hardly encompasses all individuals. The most optimistic estimates suggest that approximately 20% of the population inclines towards morningness and an equal proportion inclines towards eveningness (Adan, Natale, and Caci 2008; Tonetti, Fabbri, and Natale 2009). However, this distinction does not account for approximately three-fifths of the population which does not exhibit these extremes in sleep habits (the problems with categorisation are further elaborated Chapter 2.2.). Even if intermediate types are more adaptable by having a certain flexibility in their sleeping patterns, they still develop significant sleep debt triggered by social obligations such as school and work, being forced to use an alarm clock instead of acting on their natural circadian rhythms. The majority (70%) of the population in fact suffers from sleep debt of up to one or even two hours (Roenneberg et al. 2012; Roenneberg, Wirz-Justice, and Merrow 2003; Wittmann et al. 2006).

1.1.1. Social jetlag

Although much of the literature elaborates on the differences between circadian preferences, some works (e.g., Evans, Kelley, and Kelley 2017b; Mathew et al. 2019) suggest that these differences are in fact inequalities caused by the inconsistency between biological and social rhythms. This inequality results in a "sleep debt" referred to as social jetlag, named after a similar phenomenon induced by air travel, accumulated during weekdays and often reflected in longer sleep times on free days (Roenneberg et al. 2012; Wittmann et al. 2006). Unfortunately, social jetlag is not easy to recover from. Contrary to the popular belief that this sleep debt accumulated throughout the working week can be compensated for on the weekend, it takes four days to recover for every single hour of sleep lost (Kitamura et al. 2016). Naturally, social jetlag is also more likely to occur among certain groups of people. For example, women tend to score higher in social jetlag than men (Komada et al. 2019). Several studies have shown that evening types (Adan et al. 2012; Merikanto et al. 2017) and shift workers such as nurses (Roenneberg and Merrow 2016) are more likely to experience social jetlag. Some evidence, however, suggests that morning types also suffer from social jetlag (Roenneberg et al. 2013). Since around 70% of the population suffers from at least some social jetlag, intermediate types

must therefore also be affected. Social jetlag generally relates to unhealthy behaviours such as smoking or excessive coffee consumption (Gabud et al. 2015; Wittmann et al. 2006). People suffering from social jetlag also experience more health problems such as obesity (Roenneberg et al. 2012), which might lead to diabetes, cardiovascular diseases (Islam et al. 2018; Parsons et al. 2015; Wong et al. 2015) and depression (Levandovski et al. 2011a). Negative consequences include short-term effects such as decreased academic performance (Haraszti et al. 2014), impaired cognitive function (Panev et al. 2017), and lowered feelings of well-being (Levandovski et al. 2011a); long-term effects are increased risk of obesity (Roenneberg et al. 2012), chronic diseases linked to obesity (Koopman et al. 2017) and cardiovascular diseases (Wong et al. 2015). Social jetlag may also increase the risk of cancer (Borisenkov 2011; Fangyi Gu et al. 2017; VoPham et al. 2018) and reduce life expectancy (Borisenkov 2011). Some evidence points to a possible reciprocal relationship between social jetlag and quality of life, suggesting causality: in a study of nursing students, a higher quality of life score was associated with lower social jetlag, more positive emotional states, greater resilience and fewer depressive symptoms (Chang and Jang 2019).

1.2. The social perspective of sleep

"How we sleep, when we sleep, where we sleep, what meanings we attribute to sleep, who we sleep with, are all important socially, culturally and historically variable matters. Sleep, like waking life, is woven into the very fabric of our everyday or every night lives, and is socially managed, scheduled and institutionalised in various ways." (Williams 2008:640)

The introduction to this dissertation has so far focused on the significance of sleep and its relation to salient issues in societies around the world today. In summary, what signifies the importance of sleep to individuals and society as a whole? This section, however, aims to emphasize a detail that is not necessarily straightforward but central to the dissertation, that sleep at its very core is social and is also affected by and affects various social factors.

Alongside food, water and air, sleep is a fundamental biological requirement for human life. These requirements are also socially driven, dictated by the environment and subject to interpersonal and societal factors that also create variations in sleep behaviours and practices. While the intrapersonal and interpersonal differences which affect sleep are somewhat intuitive and point to age, sex, race/ethnicity and socioeconomic status, factors

at the societal level involve globalization, technology and public policy (Grandner 2017). Researchers suggest that sleep is an interdisciplinary topic which relates to all aspects of our lives because the body's internal clock will determine the difference between happiness and depression, health and illness and even life and death (Kelley and Griffiths 2018). People generally spend one third of their lives sleeping and one third working. The two are indisputably linked. For example, shift work at night heavily modifies sleep patterns, with various social and health consequences (Pan et al. 2011; Rathore et al. 2012; Schernhammer et al. 2011). Interestingly, amid a pandemic of sleep deprivation and contrary to the general recommendations of the American Academy of Sleep Medicine and the Sleep Research Society (Watson et al. 2015), modern-day work firmly reflects a social climate of macho culture, where sleep is deemed for "wimps" (Williams 2008) and shorter periods of sleep (five or six hours or even less) is an indicator of hard work and utmost dedication to one's work, especially among entrepreneurs, politicians and presidential candidates. The 24-hour society has facilitated a dramatic increase in night activity and consequently affected the sleep-wake cycle of both adults and children (Oka, Suzuki, and Inoue 2008). Social factors such as family and work/school environments and social interactions overall have an important roles in the daily sleep-wake rhythm, sleep quality and feelings of well-being (Belísio, Louzada, and Azevedo 2010). Sleep also plays a role in relationships: partners tend to sleep worse after conflicts (Hicks and Diamond 2011) and are also more likely to end up in a conflict after a night of poor sleep. Unsurprisingly, partners are also much less satisfied with the quality of the relationship if either partner experiences poor sleep (Gordon and Chen 2014).

Sleep is also a subject suitable for analysis from a public health perspective as an applied field whose emphasis is on a sociological perspective. In public health, it is even more common to discuss sleep and related variables and the intertwined character of biomedical and social spheres. One of the most popular topics discussed in relation to sleep is sleep deprivation as a public health epidemic (National Sleep Foundation 2014) and sleep as an overlooked and underestimated lifestyle factor and substantiated component of the human immune system. If a person does not obtain sufficient good quality sleep, the person weakens their immunity and elevates their risk for disease (Prather et al. 2015). While the full economic impact of poor sleep is unknown, accounting for only medical care costs, it is estimated that tens of billions of dollars are spent annually on medication and visits to doctors and hospitals because of problems with sleep (Burgard and Ailshire 2009). In addition to the cost to health, poor and insufficient sleep increases the risk of a costly

mistake; for example, it is estimated that approximately 22% of traffic accidents are the result of sleep deprivation (Garbarino et al. 2001). A strong correlation exists between medical errors and sleep deprivation among resident medical doctors who work excessive hours, including night shifts (Burgard and Ailshire 2009). Some of the most devastating human health and environmental disasters have been partially attributed to fatigue-related performance impairments (Colten and Altevogt 2006).

Although sleep is primarily a physiological process, it has a great impact on the social aspects of life, and the relationship is bi-directional. Unfortunately, most of the emphasis of research is on the biological layer of sleep, and the psychological and sociological layers remain underestimated. An improved connection between all these spheres would deepen our understanding of sleep and ultimately its effects on well-being and quality of life (Gordon, Mendes, and Prather 2017).

1.3. The social significance of sleep

Modern life involves stress from many directions, and it can be a struggle for individuals to achieve a balance in the time devoted to employment, family, social life and personal care. People frequently choose to cut back on sleep instead of other activities (Kroese et al. 2014) without realising the adverse consequences of chronic sleep deprivation, such as increased risk of depression (Al-Abri 2015), poor health (Luyster et al. 2012), conflict with partners (Wilson et al. 2017), and poor work performance (Chiang et al. 2014). Inadequate sleep is associated with a wide range of overall detriments to social, psychological and physical health (Lund et al. 2010) and generally less happiness and optimism (Biber et al. 2021; Doolin et al. 2018; Lemola et al. 2013). In recent years, lifestyles have seen significant change; for example, it is now more common to work remotely (EUROSTAT 2021), permitting greater flexibility in both work and social arrangements. Sleep, however, still ranks behind, considered more of a luxury instead of a pillar of healthy lifestyles (Alvarez and Ayas 2004) despite its undeniable importance. During sleep, the brain processes new information and the body removes toxins, recuperates, re-energises and releases hormones and proteins (Adam 1980; Adam and Oswald 1977). Healthy sleep routines also have a positive impact on physiology and psychological well-being, which, in turn, also affects the social aspects of people's lives. The section above introduced the concept of circadian preferences and argued why using this typology might not be ideal. The term social jetlag was also discussed as an inequality phenomenon which is significantly more prevalent in the population regardless of the

circadian preference typology. The critical importance of sleep was highlighted in relation to most frequently discussed topics that all have sleep, social aspects of life and quality of life in common. The sections below introduce and briefly discuss three thematic areas: daylight saving time (DST), the Covid-19 pandemic and Generation Z.

1.3.1. Daylight saving time (DST)

The first country to introduce DST was Germany in 1916 in an effort to reduce energy costs during World War I. Much has changed, however, and recent studies question the effectiveness of DST (Kellogg and Wolff 2008; Kotchen and Grant 2011; Shaffer 2019). While the number of countries which change the clock in summer has decreased over the century, around 40% of countries still follow this practice. Until quite recently, few studies have investigated the impact of DST on health and well-being. Evidence now indicates that any change to the clock in summer is harmful to well-being, life satisfaction and mood (Kountouris and Remoundou 2014) and linked to work-related injuries (Barnes and Wagner 2009; Lahti et al. 2011) and traffic accidents (Coate and Markowitz 2004; Huang and Levinson 2010; Lahti et al. 2010; Varughese and Allen 2001). Alarmingly, DST in spring causes an increase in suicide rates (Lindenberger, Ackermann, and Parzeller 2019). A growing body of literature also shows that any change to the clock, even if only by one hour, disturbs the human circadian rhythm and renders it impossible for individuals to adapt to long-term bi-annual changes (Allebrandt et al. 2014; Kantermann et al. 2007), causing inconvenience to some but having serious consequences for others (Manfredini et al. 2018). This is especially significant, because strong links have been found between sleep and all the above-mentioned factors, leading to difficulties such as reluctance to engage in social life. Specifically, scientific evidence exists for poor sleep triggering loneliness and social rejection (Ben Simon and Walker 2018) and poor mood being likely to affect social relationships.

One economic study applied a quasi-experimental design to challenge DST by calculating the potential of a population which obtains an extra one hour of sleep. The study found that hospitals would have significantly fewer admissions and that work productivity would be boosted (Jin and Ziebarth 2020). As already mentioned above, any cost-saving benefits DST may have had no longer appear to be significant. For several years now, agreements on cancelling DST and unifying time across Europe have been reached, but none have been established because of a lack of consensus on which time to keep.

1.3.2. Covid-19 pandemic

Modern life has accelerated everything: production, fashion, communications, food, and so on. Although some aspects of life are much more convenient, a rushed lifestyle is now also the norm. The recent Covid-19 pandemic, however, drew great attention towards lifestyles and the knowledge and realisation that overall well-being is linked to lifestyle (Caroppo et al. 2021). The most effective prevention and treatment of Covid-19 was supportive care involving a healthy diet, reasonable level of physical activity, good mental state and sufficient, good quality sleep (Balanzá–Martínez et al. 2020). This observation also applies to many other diseases, for example the common cold (Prather et al. 2015).

Life as it once was changed with the Covid-19 pandemic. Suddenly more time was available to dedicate towards different ways of living, although not everyone may have used the opportunity to introduce positive changes. People who already exercised and ate healthy food put more time and effort into those activities, but others who had hardly ever done any physical activity stopped completely and succumbed to eating out of boredom (Caroppo et al. 2021). On average, the general population reported reduced physical activity and poorer eating habits during full restrictions and home confinement, being unable to compensate for the significant increase in time spent in sedentary activities (Caroppo et al. 2021; Di Renzo et al. 2020). Significant changes or the complete loss of daily routines alongside changes in work and family dynamics also affected sleep and degraded sleep quality (Kocevska et al. 2020; Targa et al. 2021). In some cases, social jetlag dropped significantly (Leone, Sigman, and Golombek 2020; Sinha, Pande, and Sinha 2020) because sleep duration increased (Blume, Schmidt, and Cajochen 2020; Cellini et al. 2020; Di Renzo et al. 2020), likely as a result of spending more time at home and having more time for sleep on both workdays and weekends, leading to a more consistent sleep routine. In other cases, people exhibited higher social jetlag, mainly adolescents, women and persons with poorer overall sleep quality (Blume et al. 2020; Cellini et al. 2020; Leone et al. 2020; Sinha et al. 2020), possibly as a consequence of excessive screen time and mental distress (Majumdar, Biswas, and Sahu 2020).

Although many of the changes to sleep patterns were beneficial, the results of these changes were mixed, some being positive, such as longer sleep duration and lower social jetlag, others being clearly harmful, such as decrease in sleep quality, especially since sleep quality is by far the strongest predictor of quality of life among all the factors

involved in sleep (Jean-Louis, Kripke, and Ancoli-Israel 2000; Ritsner et al. 2004; Zeitlhofer 2000). Quality of sleep also correlates with life satisfaction (Blackwell et al. 2020; Duong 2021; Ness and Saksvik-Lehouillier 2018; Zhi et al. 2016) and physical and mental well-being (Bates et al. 2002; Chaput et al. 2020; Fuligni and Hardway 2006), all which were reduced along with quality of life during pandemic lockdowns (Choi et al. 2021; de Vries, Horstmann, and Mussel 2022; Yang and Ma 2020).

Restriction of lifestyles under emergency measures for the Covid-19 pandemic was temporary, however. This is evident from estimates of home office use in the Czech population: about 4–8% of employees were already partially working remotely before the Covid-19 outbreak, increasing to around 11% during the pandemic (Kyzlinková, Veverková, and Vychová H. 2020). Although no reliable statistics are currently available on remote working post-lockdowns, it is a reasonable assumption that most people returned to working in offices after emergency measures were lifted. Regardless of our positive or negative perceptions of the impact of Covid-19 pandemic measures on sleep (and other aspects of lifestyle), those effects are likely to have diminished in significance since that time. However, to verify that hypothesis, we will need to collect data for some years in the aftermath.

1.3.3. Generation Z

People popularly referred to as ‘Generation Z’ provide a good and timely example of the importance of sleep and its effects on overall well-being. Generation Z, or people born from 1997 onwards (Dimock 2019), are often described as analytical, pragmatic, authentic and also open and understanding (Francis and Hoefel 2018). People of Generation Z were raised in a world of advanced technology, as “digital natives”, which resulted in behaviours, attitudes and lifestyles dramatically different from previous generations (Dimock 2019). This generation, especially among university educated people, also has an unfortunate darker side, characterized by a high incidence of anxiety, stress and depression (Batra et al. 2021; Gusman et al. 2021; Rogowska, Kuśnierz, and Bokszczanin 2020; Ulrich et al. 2021), poor sleep quality (Batra et al. 2021; Benham 2020; Ellakany et al. 2022; Lukowski et al. 2022; Oswalt and Wyatt 2014; Ulrich et al. 2021; Yang et al. 2003) and sleep deficiency (Carskadon et al. 2012; Lund et al. 2010; Medeiros et al. 2001; Taylor and Bramoweth 2010; Tsai and Li 2004). Although insufficient evidence exists regarding the protective value of sleep in this particular age group, regular, sufficient and good quality sleep is generally linked to well-being and

satisfaction with life in many other population groups (Blackwell et al. 2020; Chaput et al. 2020; Duong 2021; Ness and Saksvik-Lehouillier 2018). It is probable that the relationship between stress and sleep is reciprocal: the "Sunday Scaries" is a term prevalent among one-third of Generation Z. This colloquialism describes the difficulty of falling asleep on Sunday nights compared to other nights of the week due to worries over work (American Academy of Sleep Medicine 2022). It is alarming that a generation of people now in their twenties, who are either studying at university to prepare for future employment or who are employed and working hard for a living and facing crises in housing, economics and the environment are entering adult life and a labour market already burdened with mental health problems and poor lifestyles (including poor sleep habits): this generation of people can anticipate lower levels of life satisfaction, well-being and overall quality of life.

1.4. The Czech context and its contribution to the general discussion

This section elaborates only on the existing sleep research performed on the Czech population to clarify the dissertation's contribution to knowledge in this context and its input to the general discussion while also highlighting the link between sleep and quality of life.

An interesting study explored exclusively the geographic occurrence of circadian preferences in the Czech population (and their characteristics, e.g., age, gender, pet ownership, etc.); the authors concluded that Standard Time is a more reasonable choice than DST for Czechia and neighbouring geographic regions (Sládek et al. 2020).

Some research exclusively studies sleep or investigates sleep as an aspect of health. An example is a World Health Organization collaborative cross-sectional study, currently being conducted in 47 countries across Europe and North America – *Health Behaviour in School-aged Children (HBSC)* (WHO 2022). The most recent results from this adolescent survey (Gariepy et al. 2020) indicate a significant discrepancy between school and non-school days: adolescents typically sleep less on school days (8 hours and 13 minutes on average in the CR) and more on non-school days (9 hours and 38 minutes on average in the CR). Older adolescents sleep for shorter periods and also have higher social jetlag than younger adolescents, suggesting that this group requires more sleep than they actually obtain. The study has also investigated sleep duration, timing and consistency in over 165,000 adolescents from 24 primarily European countries. From this sample of

adolescents, 15,432 were from the Czech Republic. Sleep duration ranged from 7 hours 47 minutes to 9 hours 7 minutes on school days and 9 hours 31 minutes to 10 hours 22 minutes on non-school days. A considerably smaller proportion of the students obtained the recommended sleep duration on school days (32–86%) than students on non-school days (range 79–92%). An interesting secondary result of the study hints at a link between lower SES and shorter sleep duration.

The Institute of Health Information and Statistics of the Czech Republic (*Ústav zdravotnických informací a statistiky ČR*) (Rodriguez 2020) has stated that an increasing number of Czechs are suffering from sleep disorders caused by both physical problems and psychological conditions such as stress. Since 2008, the number of people seeking professional help has doubled. These data come from the pre-pandemic year 2018 and reflect only the reported official numbers of people who have decided to seek help; the number of people with sleeping disorders in the CR is likely to be even higher, however. As final examples, the National Institute of Mental Health (*Národní ústav duševního zdraví*) is a reference research institution for mental health in the Czech Republic. A research centre for sleep and chronobiology is also currently working on an extensive study of the impact of Covid-19 on sleep. Preliminary results (NUDZ 2022) suggest widespread insomnia (60% of respondents) lasting for months and even years, a condition which can adversely affect the overall long-term quality of life.

Although some research streams are already studying sleep in the context of quality of life in the Czech Republic, certain knowledge gaps still need to be addressed. First, the sample populations studied are usually very specific (children, adolescents, or people suffering from the effects of Covid-19). Second, the research aims are more descriptive in character and do not address informed discussion of the effects of sleep and various aspects of sleep on quality of life. Much is still to be learned.

2. Introduction to articles

This dissertation offers an alternative to conventional studies in social sciences, specifically sociology. While it might not be entirely clear at the beginning of the introduction to the dissertation subject that sleep has a sociological component, the social effects and consequences of sleep should be apparent at this point. After this general introduction, I provide the introduction to the main part of this dissertation: introduction to articles.

The structure of this section is as follows: the research questions central to the subject, the data used for the research, and the sleep measurement tools for analysis are presented in detail. The body of the dissertation contains three chapters which explore the research questions from different perspectives. Chapter 3 discusses the effects of sleep and changes over time on quality of life; Chapter 4 examines the work and family context in relation to social jetlag; Chapter 5 discusses family background as a factor in sleep and compares the difference in sleep in parents with children of specific ages and people who are childless. The final part of the dissertation provides a summary and detailed analysis of the obtained results. An examination of the research limitations and recommendations beyond the typical journal length is presented. I also reflect on the lessons learned throughout my PhD research. Finally, I conclude the dissertation.

2.1. Research question

The dissertation introduces the subject of sleep and its relevance to social sciences, especially from the perspective of well-being and overall quality of life. From the literature review, a number of focal points and hypotheses arise in relation to a commonly proposed research question: *How is sleep associated with quality of life among Czechs?* As my research progressed over the years, I decided to break this research question into more concrete, separate concepts, which then became central to each of the academic articles included in this dissertation:

1. What are the long-term effects on quality of life of changes in sleep duration, sleep quality and the time of day when individuals sleep? (Chapter 3: Better Sleep, Better Life? Testing the Role of Sleep in Quality of Life)
2. What is the link between the magnitude of social jetlag and factors related to occupational type and specific family obligations? (Chapter 4: Social Jetlag: Work and Family Correlates)
3. Do sleep duration on workdays and free days and social jetlag differ between parents and childless people? (Chapter 5: Sleep Practices among Parents and Childless Individuals)

Even though the original question is rather general and broad, I am confident that the dissertation's conclusions will provide at least partial answers and some interesting incentives for future research in this area.

2.2. Data and methods

The dissertation draws conclusions using quantitative methods. The three academic studies corresponding to three chapters of the dissertation applied CHPS, which is a survey of the Czech population. Each study demonstrates a different statistical technique: mixed, multilevel repeated measurement models with random intercepts (Chapter 3), multilevel mixed-effects models (Chapter 4), and propensity score matching (Chapter 5). Although the techniques differ, the measurement methods and data were the same and are discussed below.

2.2.1. Data

Because the data used in the research are also described separately in each article, I only briefly summarise the CHPS here. The CHPS is a sample survey dating back to 2015. Since then, the survey has repeatedly (annually) interviewed a random sample of Czech households in Czechia. The numbers of participating households for each successive year are as follows: 5,159 (2015), 4,147 (2016), 3,616 (2017), 1,609 (2018), 1,533 (2019), and 1,311 (2020). The first four waves (2015–2018) were full surveys consisting of inter-disciplinary methods applied from sociology, economics and political science. The fifth wave (2019) was conducted under a different project which studied the cumulative effects of social disadvantage on health and the quality of life. While also full in scope, its aim was to connect the Institute of Sociology and Institute of Physiology of the Czech Academy of Sciences and to combine their research to obtain both sociological and epidemiological data. The sociological data was collected using questionnaires. The epidemiological component involved venous blood sampling of approximately 2,000 respondents from the original survey, with the aim of measuring various biomarkers. The last two surveys (2019 and 2020), were short versions of the previous waves since the overall objective had changed, in which CHPS respondents were incorporated into the national Covid-19 antibody testing programme. Since then, no follow-up waves of the CHPS survey have been conducted, although new data collection is scheduled for 2023 and should start where the previous investigation finished. Data on sleep variables were obtained in the CHPS in waves 4–6 (2018–2020).

2.2.2. Measurement methods

The data used in all three articles presented in this dissertation (Chapters 3, 4 and 5) were taken from the same panel survey; the measurement methods for processing sleep

variables were also the same. For clarity, because the specific measurement methods are already thoroughly described in each article, only a brief summary of the Munich Chronotype Questionnaire (MCTQ) is given here. The 17-item MCTQ was developed by Roenneberg, Wirz-Justice and Merrow (2003). It measures parameters such as sleep duration, sleep timing (circadian preference) and the misalignment between biological and social rhythms (social jetlag), but it also includes optional modules, for example, on the effects of light exposure, etc. Determining circadian preference requires calculating the sleep midpoint on workdays and correction for oversleeping on free days. The resulting differences between the midsleep times on free days and workdays describes the degree of social jetlag (Roenneberg et al. 2012). The MCTQ has its benefits and limitations. One of its most important features is providing discrete information about free days and workdays. The resulting variables are also continuous, not categorical, as with other measurement questionnaire tools. The MCTQ therefore generally follows a normal distribution similar to any other population characteristic (such as height or weight), with very few extremes. No precise cut-off points are provided. If these are required, working with medians, quartiles or deciles is recommended (Roenneberg et al. 2015). Interestingly, circadian preferences were first described in 1885 by Gowers, who classified patients into three groups identical to the morning, evening and intermediate types described today. Later studies, however, suggested that circadian preferences should not simply form three distinct categories but be described as a spectrum (Hofstra and de Weerd 2008). Depending on the research question, the advantage (or disadvantage) of the MCTQ is that it measures only the existing condition, not personal preferences. If a person is an evening type yet follows the morning type schedule, the MCTQ is capable of determining only the actual timing. If measurements of preferences are required, alternative measurement tools must be used. This main limitation is comparable to the limitations in any other subjective measurement methods. It should be noted that although the measurements obtained with devices such as smart watches or rings and mobile phones or in a laboratory environment might be objective and seem ideal, they also have certain limitations. I elaborate on this further at the very end of the thesis in the Limitations section.

A brief overview of alternative methods often applied to measure various sleep variables is also relevant at this point. Apart from the MCTQ, the Morningness–Eveningness Questionnaire (MEQ) developed by Horne and Östberg in 1976 (Horne and Östberg 1977) is also designed to assess morningness and eveningness. The MEQ uses 19

questions, and in contrast to the MCTQ, it measures personal preferences, not precise times, and produces a score on a morningness–eveningness scale which places the respondent into one of the groups (morning, evening or intermediate type). The MEQ has also been adapted to measure circadian preferences in children and adolescents (MESC). Many other measurement tools for sleep, circadian preference and social jetlag are commonly used. The Composite Scale of Morningness (CSM) or Lark–Owl circadian preference indicators, however, are not so widely used. Another option is to use, for example, experimental conditions to measure the effect of complete darkness on the circadian rhythm and overall sleep activity. This experiment requires months to complete, and besides being lengthy and expensive to perform, it requires a suitable environment which involves participants and researchers spending the entire time in a cave in complete darkness. Another option is to draw blood and measure biomarkers (e.g., melatonin and cortisol) (Zerbini and Merrow 2017).

3. Better sleep, better life? Testing the role of sleep in quality of life

Abstract

Previous research has shown that sleep deprivation, low quality sleep or inconvenient sleeping times are associated with lower quality of life. However, research of the longitudinal effects of sleep on quality of life is scarce. Hence, we know very little about the long-term effect of changes in sleep duration, sleep quality and the time when individuals sleep on quality of life. Using longitudinal data from three waves of the Czech Household Panel Study (2018–2020) containing responses from up to 4,523 respondents in up to 2,155 households, the study examines the effect of changes in sleep duration, sleep quality and social jetlag on satisfaction with life, happiness, work stress, subjective health and wellbeing. Although sleep duration and timing are important, panel analyses reveal that sleep quality is the strongest predictor of all sleep variables in explaining both within-person and between-person differences in quality of life indicators.
Keywords: sleep, social jetlag, wellbeing, health, happiness

Introduction

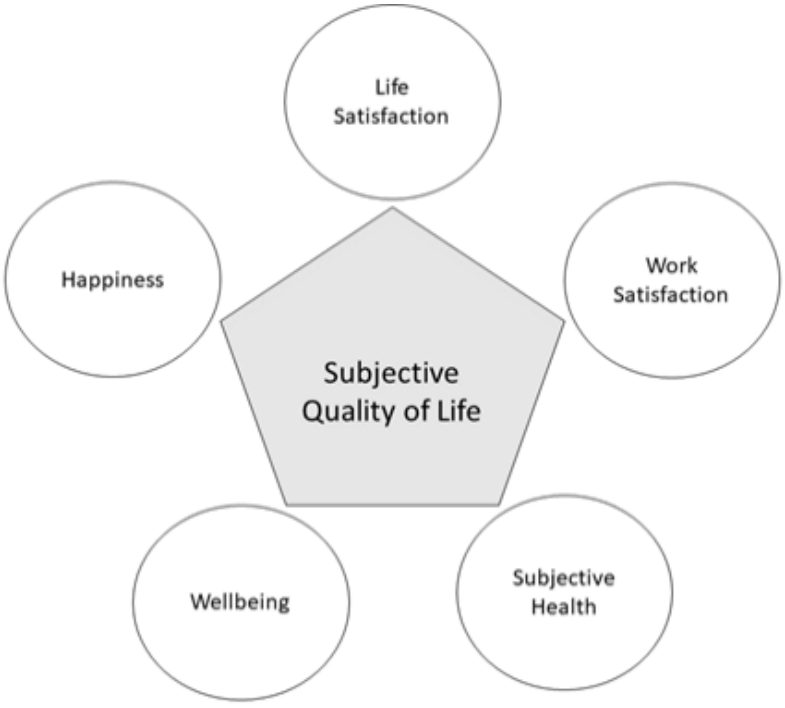
Previous research has shown that sleeping patterns are related to quality of life (QoL) and that key aspects are the time when individuals sleep, sleep duration and sleep quality. People who obtain sufficient high-quality sleep at proper times were found to have better general health [1] and overall quality of life [2]. By contrast, individuals who sleep too much [2] or sleep poorly [3] exhibit diminished quality of life. Despite previous research on QoL and sleep being substantial, they often lack in depth and scope and we know little about the effects of these three aspects of sleep on QoL and the development of their influence over time, which are significant considerations. Using three waves of the Czech Household Panel Study data, the present study contributes to the literature by examining the effect of sleep duration, sleep quality and social jetlag on five QoL indicators and exploring the trends in time.

Quality of life definition

Originally, high QoL was perceived as a lack of stress, but the idea evolved into a multidimensional concept which emphasizes the subjectivity of experience, function and wellbeing and encompasses the physical, psychological and social domains of life [4]. QoL is an interplay between the perception of an internal state, such as the experience of happiness or feeling of good health or satisfaction, and external events in the surrounding environment, which may include family and career [5].

The model in the present study was built according to the theoretical model of QoL by Ventegodt et al. [6]. The model comprises various parameters grouped into three complementary categories, each being concerned with an aspect of good life: subjective, existential and objective. The above-mentioned authors incorporated notions of QoL into an *integrative quality-of-life* (IQOL) theory. We base our analysis on the subjective component of this all-embracing theory, which includes the following parameters: wellbeing, satisfaction with life, happiness and meaning in life (Fig 1).

Fig 1. Subjective quality of life according to integrative quality-of-life (IQOL) theory.



Note: Modified model of Søren Ventegodt et al. (2003:1032) integrative quality-of-life theory. The indicators for the five dimensions of quality of life refer to the indicators used in the Czech Household Panel Survey.

These IQOL parameters are intertwined and crucial factors in describing QoL [4]. For instance, subjective wellbeing might be characterized as an emotional response and evaluation of satisfaction with life [7] which includes both cognitive judgments and affective reactions [4]. Since wellbeing captures a person's emotional state and touches

on their mental state, our interpretation regards these states as complementary to subjective health, which more straightforwardly encompasses physical aspects. While happiness could be described as a person's current positive emotional condition [8], satisfaction with life represents a stable assessment of general feelings about life and indicates a long-term attitude [8]. Work also forms an important part of life, contributing to its meaning [6]. Although work can be exciting and satisfying, it may also be a cause of stress. Work stress refers to a negative psychological state which may involve numerous conditions in the working environment and consists of an interplay of cognitive, affective and physiological reactions functioning as stressors [9]. Stress causes the anatomic nervous system to release the hormone cortisol, which commonly aids in regulating sleep cycles. At elevated levels, however, cortisol results in sleep disturbances and insomnia [10]. Insufficient, excess, poor or otherwise impaired sleep, especially in the long-term, is concerning since it may result in severe physical, mental and social consequences in quality of life.

Previous research

Quality of life and its relationship to sleep

According to *Repair and Restoration theory* (RRT), sufficient sleep rewards us with restoration and repair that no other physiological process is able to achieve [11]. After a good night's sleep, individuals feel mentally sharp and rested. Research on body functioning also suggests that muscle repair, tissue growth and many other essential processes occur primarily during sleep [12], thereby affecting wellbeing and QoL. By contrast, insufficient sleep and accumulated sleep debt impairs mental function [13] and leads to health problems, including depression [14], obesity [15], diabetes and cardiovascular disease [16], increases the risk of cancer and reduces life expectancy [17]. IQOL and RRT theories and strong empirical evidence indicate that sleep affects QoL. Not only that sleep, in theory, restores the body and elevates the mind, studies have confirmed that sleep predicts quality of life, not the opposite [18,19]. Previous research suggests three aspects of sleep are related to QoL: sleep duration, sleep quality and social jetlag.

Sleep duration

Sleep duration is a reliable predictor of wellbeing [18] and affects QoL. A systematic review and meta-analysis by Cappuccio et al. [20] found that both too short and too long

periods of sleep lead to elevated mortality. There is, however, no agreement in the literature on what is normal, short or long sleep duration, each study used different cut-off points. This is also a reason why our study relates only to relative time spent sleeping (less or more hours in comparison to other respondents).. A longitudinal study of 1,601 Swiss and Norwegian adolescents concluded that longer sleep duration is associated with higher levels of wellbeing [18]. In another study of adolescents (n = 4,582), shorter sleep duration was related to a lower level of happiness [21]. Ness and Saksvik-Lehouillier [22] surveyed 474 Norwegian university students and concluded that longer average sleep duration is associated with greater life satisfaction.

However, some studies, such as a two-decade old experiment involving 75 university students who maintained sleep logs for three seven-day periods over three months and subsequently took part in a survey [23], claim that sleep quantity does not contribute to wellbeing. Two recent studies drawing on the German Socio-Economic Panel separately investigated sleep duration on workdays and weekends: Pagan [24] observed a sample of 105,340 individuals with disabilities for six years (2008–2013) and concluded that longer sleep duration on workdays increases life satisfaction. Piper [25] explored a sample of 68,782 individuals from the same panel data (2008–2012) and found that life satisfaction increases with longer sleep duration during workdays but not on weekends. In a study of 547 university students, Önder [26] found no correlation between sleep duration and happiness. However, the reliability of these conclusions is debatable since they were both based on small student samples, and the Turkish study involved mainly women (80.4 %). Similarly, a longitudinal two-year study of 1139 Chinese university students indicated that sleep duration does not predict QoL [27]. Besides sleep duration, sleep quality is also related to wellbeing [1,22,23] and overall QoL [28–30].

Sleep quality

Although sleep quality is often considered affecting QoL more than sleep duration, they are not usually investigated together, the focus being solely on sleep quality. One notable example used a representative Austrian sample of 1,049 people and showed the significance of the relationship between sleep quality and QoL [30]. Research based on representative samples is scarce, and studies have principally involved student samples or patients.

Poorer sleep was found to be associated with adverse effects and significantly lower levels of happiness [21] and life satisfaction among Norwegian [22] and Korean students [19]. The above-mentioned small-scale experiment by[23] on college students in the US

revealed no effect of sleep quantity on QoL but found sleep quality to be a strong and consistent long-term predictor of QoL. In an experiment on the interaction of sleep with campus residence and its effect on wellbeing, the authors of a Chinese study of university students concluded that overall sleep quality deteriorated over time and that sleep had no significant effect on QoL [27]. Students are often used in experiments for their accessibility, but the general applicability of the results of studies on these samples is limited. Students are young, do not work in full-time employment, and their physiological and life characteristics differ from the general population. Other studies often use specific populations such as patients, the elderly or workers in certain heavy industries.

In a study of a specific adult and mostly male population of 145 patients diagnosed with schizophrenia, the conclusions resembled other reports in that poor sleepers tend to report lower QoL [29]. A longitudinal two-year Australian study of a sample of 93 adults with autism similarly concluded that poor sleep quality predicted poor QoL [31]. Jean-Louis et al. [1] collected sleep data on 273 adult San Diego residents (aged 40–64 years); their investigation revealed that self-perceived sleep quality is associated with wellbeing. Another cross-sectional study researched 435 female shift-working nurses in Taiwan and also concluded that poor sleep quality in the sample resulted in poorer life quality [28]. Disrupted sleep and therefore low-quality sleep, was also found to decrease QoL and increase work stress in a sample of 35,932 Korean workers [10].

Social jetlag

Previous studies have shown that sleep duration and sleep quality are crucial variables in predicting QoL. However, the time when individuals sleep is often overlooked. People must adjust the time when they sleep to social arrangements which do not often agree with their intrinsic preferences. This misalignment between our social and internal biological rhythms leads to social jetlag, which has previously been found to relate to QoL [32,33]. The relationship between social jetlag and QoL is understudied, and the results of studies are inconsistent. Only two small-scale studies have been conducted on student samples, finding no link between social jetlag and QoL [26,34]. Other studies have reported a negative correlation between social jetlag and QoL [35].

Summary of previous research

With the exception of some studies which used longitudinal data [18,23–25,31,34], the majority of studies are cross-sectional [e.g., 22,33,36] and hence, a deficit in longitudinal panel studies exists. Only two studies exploring the effect of sleep variables on the quality of life are nationally representative [25,30], while the remainder of studies were

conducted on either a few dozen [23] or few hundred [e.g., 1,22,37] individuals and mainly examined specific populations, such as adolescents [19,21,34], university students [e.g., 19,21,22,37], people with disabilities [24], people with autism [31] or patients diagnosed with schizophrenia [29]. Although Lau et al. [27] concluded that social jetlag predicted QoL, caution is required in interpreting their results. Their claim that social jetlag is reflected in perceived poorer sleep and impaired wellbeing is problematic, and their results are therefore debatable. The only accepted method of measuring social jetlag is the computation model developed by Roenneberg et al. [38]. Even though some studies have explored two aspects of sleep, for example, sleep duration and sleep quality [e.g., 21–23], or sleep duration and social jetlag [26], none have incorporated all three aspects (sleep duration, sleep quality, social jetlag), and hence, we have insufficient knowledge of the relative importance of the three most important sleep characteristics on QoL.

Based on the IQOL and RRT theories and the previous literature and considering the analytical methods allowing us to observe relative in-between and within differences, we formulated the following hypotheses on the role of sleep in QoL:

H1A. Individuals with on average longer sleep duration have higher levels of QoL than individuals with shorter sleep duration.

H1B. Increases in sleep duration over time are related to higher levels of QoL.

H2A. Individuals with on average higher sleep quality have higher levels of QoL than individuals with lower sleep quality

H2B. Improvements in sleep quality over time are related to higher levels of QoL.

H3A. Individuals with on average lower social jetlag levels have higher levels of QoL than individuals with higher social jetlag.

H3B. Decreases in social jetlag over time are related to higher levels of QoL.

Data and methods

Study design and participants

The analyses used data from the Czech Household Panel Survey (CHPS) which focuses on mapping the living conditions and describing the dynamics of change among both Czech households and individuals in the long-term perspective [39]. These data were collected annually from 2015 until 2020, typically between the end of June and the end of October. A two-stage stratified random sampling method was applied and the design effects were further mitigated by the use of a large number of small primary sampling

units. The original sampling frame from the very first data collection consisted of the Register of Census Districts and Buildings which had been transformed into an address database. Since the target population was the non-institutionalized population of the Czech Republic, all members of the sampled households were interviewed. In each of the following waves, the same members of the same households participating in the preceding wave were approached (e.g., in wave three in 2017, only participants from wave two were approached). The data are nationally representative of the adult population in CR. The retention rate of households between the first and sixth waves of data collection was 21.6 % on average, and the retention rate of individuals was 20.6 %. All information regarding data collection including survey design is available in the Czech Social Science Data Archive [39].

A total of 5,132 paper-and-pencil self-administered questionnaires (SAQ) incorporating the key variables were collected from Czech adults in 2018, 2,046 in 2019, and 2,161 questionnaires in 2020. The final dataset contained responses from up to 4,523 respondents in up to 2,155 households. The significant drop in the sample between 2018 and 2019 was caused by the blood draw requirement. Sleep variables were included into the questionnaires during the waves 4-6 (2018-2020) due to the collaboration between Institute of Sociology and Institute of Physiology of the Czech Academy of Sciences at that time. They were measured according to the Munich Chronotype Questionnaire (MCTQ): some were measured, and some were computed (for more information on used variables, see the section Measures down below). Written informed consent was obtained from all respondents. The study followed the principles of the Declaration of Helsinki and was approved by Ethics Committee of the Institute for Clinical and Experimental Medicine and Thomayer Hospital in Prague (study number G-16–05–02).

The data from the CHPS are widely used by researchers for secondary data analysis: for instance, studies are focusing on certain aspects of sleep, specifically circadian preference assessment [40] and social jetlag in the work-family context [41], other studies explore the division of housework and relative resources [42] partnership trajectories [43], mechanisms of the reproduction of homeownership [44], voter turnout [45].

Measures

We investigated the effect of sleep on the five dependent variables which describe QoL: life satisfaction, wellbeing, happiness, subjective health and work stress. At all points in time, **life satisfaction** was measured with responses to the question “All things

considered, how satisfied are you with your life as a whole?" The response options were scaled from zero to ten, zero indicating "extremely dissatisfied" and ten indicating "extremely satisfied". Many other studies have used the same items to measure life satisfaction [e.g., 46,47].

Wellbeing was calculated as an average of three items to measure how often over the last two weeks respondents "have been cheerful and in good spirits"; "have felt calm and relaxed"; "have been active and vigorous". The six response options with scores from one to six were "at no time", "some of the time", "less than half of the time", "more than half of the time", "most of the time", "all of the time". The resultant reliability estimates are acceptable (α_{t1} = .811; α_{t2} = .828 α_{t3} = .830; α_{t4} = .841 α_{t5} = .825). The scale was computed as a sum of means also ranging from one to six. The same items were measured during two out of three analysed years of data collection in 2018 and 2019 and have also been used to measure wellbeing in other studies [e.g., 48].

Perceived **happiness** was measured with the question "Taking all things together, how happy would you say you are?". The respondents were asked to answer on a scale of zero to ten, zero indicating "extremely unhappy" and ten indicating "extremely happy". The same items were measured during two out of three analysed years of data collection in 2018 and 2019 and have also been used to measure happiness in other studies [e.g., 47,49].

Respondents rated their **subjective health** according to the question "In general, would you say your health is…?" on a five-point scale of "poor", "fair", "good", "very good" and "excellent". The same items were measured during two out of three analysed years of data collection in 2018 and 2019 and have also been used to measure subjective health in other studies [e.g., 47,49].

The respondents' perceived **work stress** was calculated according to the proportion of affirmative answers to the question "Have the following circumstances in your current job caused you excess worry or stress in the past 12 months?" according to the following items: "threat of layoffs or losing the job"; "workplace safety, accidents, or injuries on the job"; too many demands or too many working hours at work." The response options were "yes" or "no". The same items were measured during one wave (2018) during the reference period. The questions are proxies inspired by the European Working Conditions Surveys (EWCS).

In addition to the dependent variables, three facets of sleep were measured. Specifically, we assessed the average sleep duration, perceived sleep quality, and social jetlag. **Sleep duration** was calculated as the average of answers to questions regarding the time when

respondents usually fell asleep and woke up on free days and when they usually fell asleep and woke up on workdays. The same items were measured during the complete analyzed period: wave 4 (2018), wave 5 (2019) and wave 6 (2020) of data collection and have also been used to measure sleep quality in other studies [e.g., 33,40].

Perceived **quality of sleep** was measured with the question "How would you rate the quality of your sleep?" according to a four-point Likert scale for the response options "very bad", "bad", "good" and "very good". The same items were measured during the complete analyzed period: wave 4 (2018), wave 5 (2019) and wave 6 (2020) of data collection and have also been used to measure sleep quality in other studies [e.g., 50,51].

Social jetlag was calculated according to a MCTQ [52] as the difference between the mid-sleep time on free days and workdays. The resultant values were converted into numeric variables which represented the hours. The results were interpreted as follows: zero indicated no sleep debt during workdays or free days, and any values above zero indicated an accumulation of sleep debt. The same items were available during the complete analyzed period: wave 4 (2018), wave 5 (2019) and wave 6 (2020) of data collection and have also been used to measure social jetlag in other studies [e.g., 14,33,34].

Data on age, gender, highest level of education attained (basic and secondary vocational, secondary with maturita, tertiary education), net household income[1] (1 = up to CZK 22,999, 2 = CZK 23,000 to 29,999, 3 = CZK 30,000 to 34,999, 4 = CZK 35,000 to 39,999, 5 = CZK 50,000 to 74,999, 6 = more than CZK 75,000), number of children below the age of five in the household, and economic status were also collected and controlled for (45.80 % employed, 6.20 % self-employed, 2.90 % unemployed, 8.88 % students, 33.07 % retired, and 3.14 % on maternity leave). The descriptive statistics for all variables used in our analyses is reported in Table 1.

Table 1. Descriptive statistics of used variables.

	Number of respondents	Mean	Std. Dev.	Min	Max
Gender (2018, 2019, 2020)	4,523	1.58	0.49	1	2
Education (2018, 2019, 2020)	4,523	1.95	0.76	1	3
Age (2018, 2019, 2020)	4,523	51.93	16.766	18	96
Household income (2018, 2019, 2020)	4,523	3.79	1.78	1	6
Economic status (2018, 2019, 2020)	4,523	1.79	1.92	0	5

[1] Net household income is stated in Czech Crowns (CZK). For illustration, according to the European Union – Statistics on Income and Living Conditions (EU-SILC), the average monthly net income of a Czech household reached CZK 17.5 thousand per person in 2019 [61]. The net household income categories used in this article can be roughly converted to USD as it follows: 1 = up to 918 USD, 2 = 918 to 1,197 USD, 3 = 1,198 to 1,396 USD, 4 = 1,397 to 1,596 USD , 5 = 1,597 to 2,993 USD, 6 = more than 2,994 USD.

Social jetlag (2018, 2019, 2020)	4,523	0.87	0.87	0	5.83
Sleep duration (2018, 2019, 2020)	4,523	7.48	1.12	3.5	13.48
Quality of sleep (2018, 2019, 2020)	4,523	3.00	0.68	1	4
Children below the age of 5 (2018,2020)	4,523	0.18	0.47	0	2
Life satisfaction (2018, 2019, 2020)	4,523	7.47	1.79	0	10
Wellbeing (2018, 2019)	3,850	4.08	0.92	1	6
Subjective health (2018, 2019)	3,867	3.12	1.00	1	5
Working stress (2018, 2020)	2,097	0.19	0.24	0	1
Happiness (2018, 2019)	3,857	7.34	1.77	0	10

Statistical analysis strategy

To test our hypotheses on the effects of the three measured aspects of sleep on life satisfaction, wellbeing, happiness, subjective health and work stress, we analysed the CHPS data according to mixed, multilevel repeated measurement models with random intercepts for individuals, households and a random slope for time. To examine whether sleep quality, sleep duration and social jetlag would predict between-person and within-person changes in the dependent variables, we constructed three-level hierarchical models with time nested within both individuals and households. The variables at the within-person level were person-mean-centred and constituted a measurement of the degree to which an individual's characteristics changed over time. The variables at the between-person level were grand-mean-centred and tested whether and how much individuals differed from each other.

We started with null models which incorporated the dependent variables without predictors to capture the variance of the dependent variables (S2 Table 1). Next, we examined the longitudinal effects of the three tested facets of sleeping hygiene on the five measures of QoL by adding sleep duration, sleep quality and social jetlag variables and interaction terms for time and sleeping variables (Models 1A–5A). In the final step, Models 1B–5B decomposed the effects of sleeping on within-person and between-person effects. We then evaluated the model fits according to the general principle that models with lower deviance and AIC values than the null model are considered better fitting models [53].

Results

Initially, we built models without predictors to examine the variance in all five of the measured aspects of quality of life. These null models (S2 Table 1) showed 47 % variance in life satisfaction between individuals and 23 % variance between households, 56 % variance in wellbeing between individuals and 20 % variance between households, 74 %

variance in subjective health between individuals and 26 % variance between households, 51 % variance in working stress between individuals and 12 % variance between households, 56 % variance in happiness between individuals and 23 % variance between households.

Do changes in sleep affect the quality of life over time?

To test the effect of sleep over time, we added sleep duration, sleep quality, social jetlag, control variables, the fixed effect of time and interaction term for time, and each of the three variables which capture sleeping (Table 2: Models 1A–5A). The variables improved model fit in all models (life satisfaction: Δ-2LL = 247.68 (16), $p < .001$; ΔAIC = 215.68; wellbeing: Δ-2LL = 404.70 (16), $p < .001$; ΔAIC = 372.70; health: Δ-2LL = 1307.65 (16), $p < .001$; ΔAIC = 1275.65; work stress: Δ-2LL = 106.62 (16), $p < .001$; ΔAIC = 74.62; happiness: Δ-2LL = 296.54 (16), $p < .001$; ΔAIC = 262.54).

Table 2. Sleeping habits and quality of life, linear mixed models with repeated measurements.

		Model 1A **Life satisfaction**	Model 2A **Wellbeing**	Model 3A **Subjective health**	Model 4A **Work stress**	Model 5A **Happiness**
Interaction terms						
	Sleep duration*time	-.02 (-.07 - .04)	.09*** (.04 - .14)	.06** (.02 - .10)	<.01 (-.02 - .01)	.15*** (.06 - .24)
	Sleep quality*time	.05 (-.04 - .14)	-.02 (-.09 - .06)	-.03 (-.10 - .04)	.01 (-.01 - .02)	-.11 (-.26 - .03)
	Social jetlag*time	-.02 (-.09 - .06)	-.06* (-.12 - -.01)	-.04 (-.09 - .01)	<.01 (-.02 - .01)	.02 (-.09 - .13)
Sleep variables						
	Sleep duration	.06 (-.14 - .26)	-.30*** (-.46 - -.15)	-.23** (-.37 - -.09)	<.01 (-.04 - .05)	-.56*** (-.85 - -.27)
	Sleep quality	.32 (-.01 - .65)	.45*** (.19 - .70)	.47*** (.24 - .69)	-.06 (-.12 - .01)	.99*** (.52 - 1.47)
	Social jetlag	.02 (-.25 - .30)	.20 (-.01 - .40)	.13 (-.05 - .30)	.03 (-.02 - .09)	-.12 (-.49 - .26)
Socio-demographic variables						
	Time	.01 (-.46 - .47)	-.53** (-.93 - -.13)	-.33 (-.68 - .03)	<.01 (-.10 - .10)	-.69 (-1.43 - .05)
	Gender (ref. cat. male)	.08 (-.02 - .19)	.07* (.02 - .13)	.09** (.03 - .14)	-.01 (-.03 - .01)	.14* (.03 - .25)
	Education – secondary with maturita	.10 (-.03 - .23)	-.03 (-.10 - .04)	.14*** (.07 - .21)	-.03 (-.05 - .00)	.08 (-.05 - .22)
	Education – tertiary	.09 (-.06 - .25)	.02 (-.10 - .06)	.26*** (.18 - .34)	-.04** (-.07 - -.01)	.15 (-.01 - .31)
	Age	.01** (.00 - .02)	<.01 (-.01 - .00)	-.02*** (-.02 - -.02)	<-.01** (-.01 - -.01)	.01** (.00 - .01)
	Household income	.14*** (.10 - .17)	.01 (-.01 - .03)	.04*** (.02 - .06)	<.01 (-.01 - .00)	.12*** (.08 - .16)
	Economic status (ref. cat. employed)					
	Self-employed	.06 (-.17 - .29)	-.09 (-.21 - .03)	.05 (-.07 - .17)	.02 (-.02 - .06)	.02 (-.22 - .26)
	Unemployed	-.31 (-.65 - .04)	-.22* (-.40 - -.04)	-.27** (-.44 - -.09)	-.04 (-.12 - .03)	-.12 (-.47 - .23)
	Student	.58*** (.30 - .87)	.17* (.02 - .32)	.24** (.10 - .38)	-.10*** (-.16 - -.04)	.49** (.19 - .78)
	Retired	.08 (-.12 - .29)	<.01 (-.11 - .11)	-.20*** (-.30 - -.09)	-.10*** (-.15 - -.05)	.22* (.00 - .43)
	Maternity leave	.27 (-.05 - .58)	-.04 (-.20 - .13)	-.03 (-.19 - .14)	-.10** (-.17 - -.03)	.02 (-.31 - .34)
	Number of children below the age of 5					
	One child	.18 (-.03 - .39)	.02 (-.09 - .12)	.08 (-.02 - .17)	<.01 (-.02 - .04)	.38*** (.16 - .59)
	Two or more children	.41* (.07 - .76)	.06 (-.12 - .24)	.16 (-.00 - .33)	<-0.01 (-.07 - .05)	.38* (.03 - .74)
Constant		4.82*** (3.06 - 6.57)	4.76*** (3.41 - 6.11)	3.94*** (2.74 - 5.14)	.45* (.09 - .82)	7.15*** (4.63 - 9.67)
	Observations	4,523	3,850	3,867	2,097	3,857
	Households	2,155	2,100	2,105	1,305	2,101
	AIC	17502	9551	9013	-60	14623
	BIC	17662	9701	9169	81	14779
	ICC households	15%	5%	7%	3%	5%
	ICC individuals	69%	94%	82%	95%	96%
	ll	-8726	-4752	-4482	55.31	-7287

Note: *** p<0.001, ** p<0.01, * p<0.05, 95% CI in parentheses

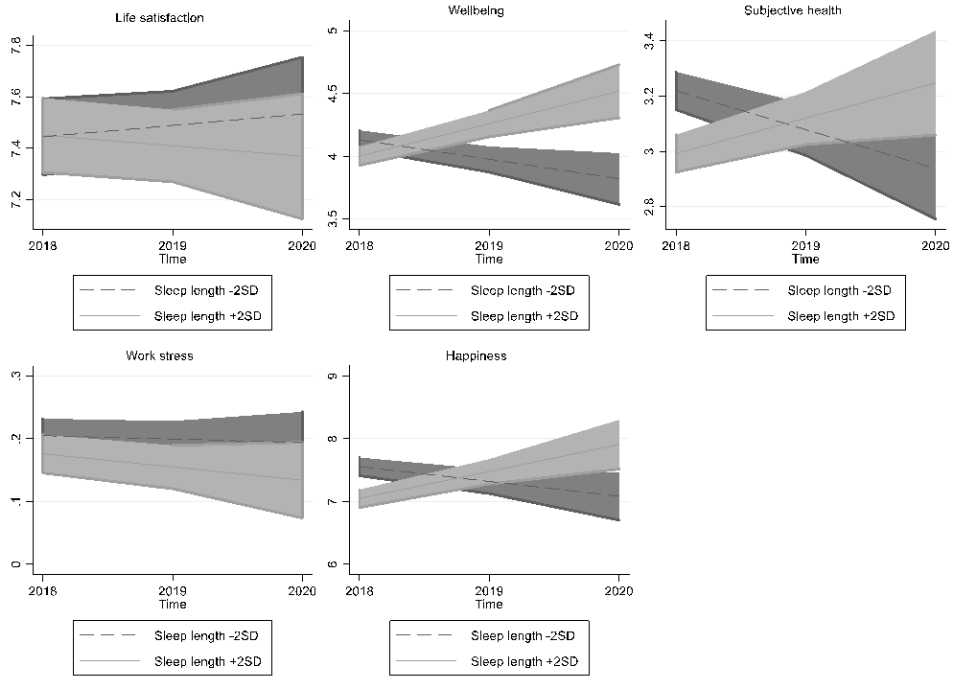
The interaction of sleep duration and the time variable was a positive and statistically significant predictor of wellbeing (B = .092, p < .001), subjective health (B = .060, p = .005), and happiness (B = .148, p = .001). The effect of the interaction term was not a statistically predictor in the model for life satisfaction (B = -.019, p = .497) or work stress (B = -.003, p = .575).

The interaction of sleep quality and the time variable was not a statistically significant predictor of any of the tested dependent variables (subjective health: B = -.029, p = .391; happiness: B = -.115, p = .110; life satisfaction: B = .050, p = .268; wellbeing: B = -.017, p = .652; work stress: B = .006, p = .562).

The interaction of social jetlag and the time variable was a negative and statistically significant predictor of wellbeing (B = -.062, p = .042), but not a statistically significant predictor in the models for subjective health (B = -.041, p = .136), happiness (B = .022, p = .700), life satisfaction (B = -.016, p = .678) or work stress (B = -.005, p = .536).

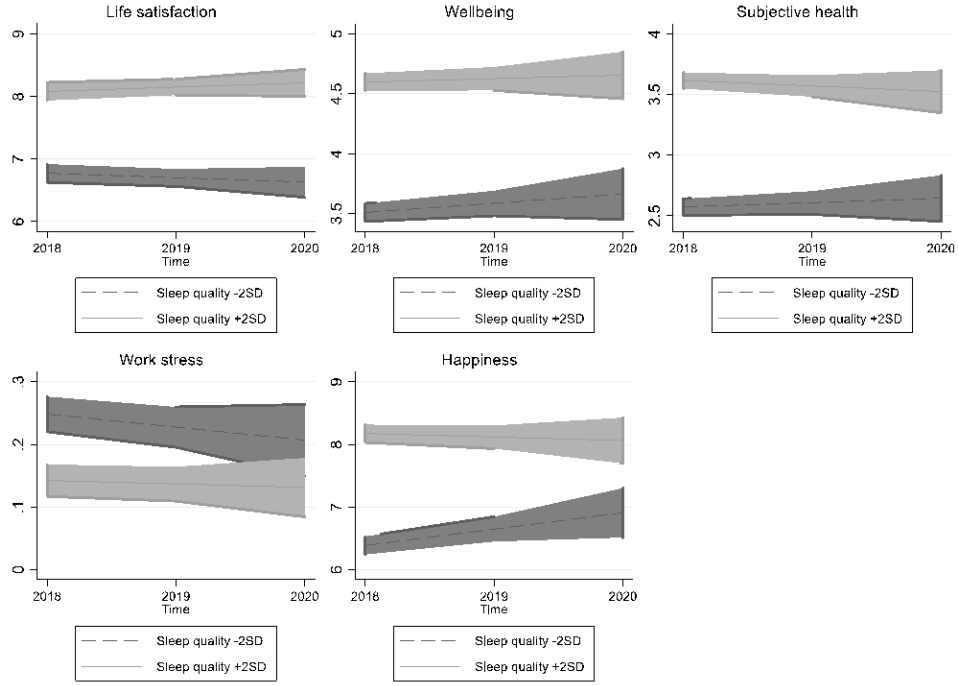
A graphical representation of the calculated marginal effects highlighted the differences in QoL between individuals who slept fewer or more hours on average (Fig 2), perceived their sleep to be worse or better quality (Fig 3), and suffered from less or more social jetlag (Fig 4), whereas other variables remained at their mean values.

Fig 2. **Sleep duration and quality of life at the individual level in time.**



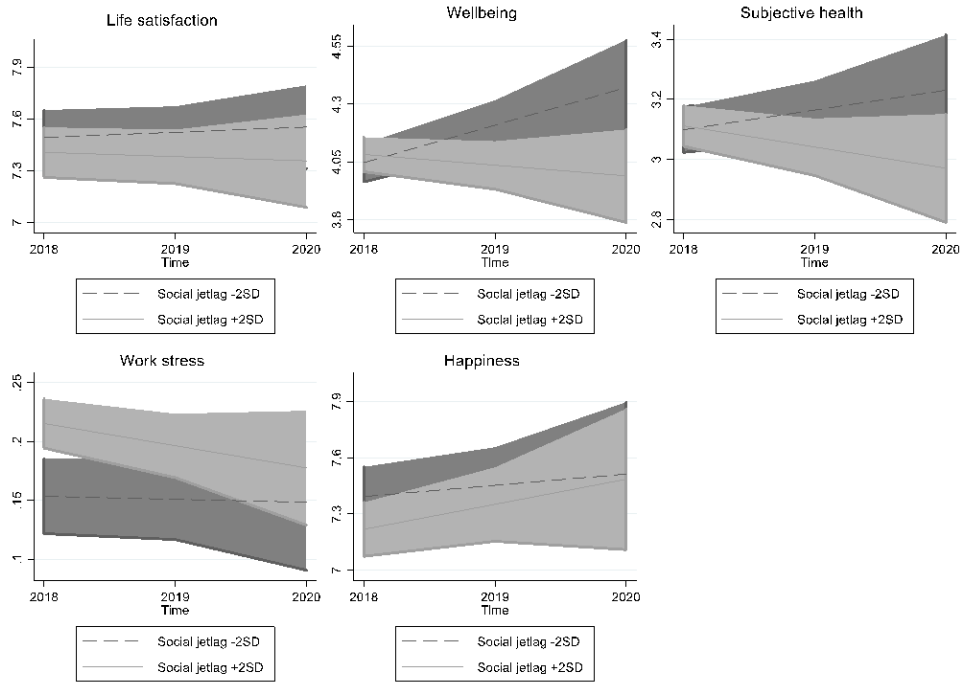
Note: 95% confidence intervals.

Fig 3. Sleep quality and quality of life at the individual level in time.



Note: 95% confidence intervals.

Fig 4. Social jetlag and quality of life at the individual level in time.



Note: 95% confidence intervals.

Does sleep predict within-person and between-person changes in quality of life?

Further examination of the longitudinal effect of sleep on quality of life in Models 1B–5B (Table 3) distinguish the discussed between-person and within-person effects. Separation of the between-person and within-person effects improved model fit in the models for predicting life satisfaction (Δ-2LL = 37.44 (1), $p < .001$; ΔAIC = 37.44), wellbeing (Δ-2LL = 15.25 (41), $p < .001$; ΔAIC = 13.25), health (Δ-2LL = 50.66 (1), $p < .001$; ΔAIC = 50.66) and happiness (Δ-2LL = 16.69 (1), $p < .001$; ΔAIC = 18.69) but did not show any statistically significant improvement in model fit for work stress (Δ-2LL = 3.184 (1), $p < .074$; ΔAIC = 3.18) over Models 1A–5A.

Table 3. Sleeping habits and quality of life, linear mixed models with repeated measurements

		Model 1B **Life satisfaction**		Model 2B **Wellbeing**		Model 3B **Subjective health**		Model 4B **Work stress**		Model 5B **Happiness**	
Sleep variables - between person level											
	Sleep duration	-.02	(-.08 - .03)	-.01	(-.04 - .02)	-.04**	(-.07 - -.02)	<.01	(-.02 - .01)	-.08**	(-.14 - -.03)
	Sleep quality	.65***	(.56 - .74)	.46***	(.42 - .51)	.47***	(.42 - .51)	-.04***	(-.06 - -.03)	.74***	(.65 - .84)
	Social jetlag	-.09*	(-.17 - -.00)	-.02	(-.06 - .02)	-.03	(-.07 - .01)	.02*	(.00 - .03)	-.08	(-.17 - .00)
Sleep variables - within person level											
	Sleep duration	-.01	(-.11 - .09)	.03	(-.03 - .08)	-.02	(-.07 - .03)	-.02	(-.05 - .01)	-.04	(-.15 - .06)
	Sleep quality	.15*	(.01 - .29)	.18***	(.10 - .26)	.14***	(.07 - .21)	-.01	(-.04 - .03)	.28***	(.14 - .43)
	Social jetlag	.11	(-.03 - .24)	.03	(-.05 - .11)	.06	(-.01 - .13)	.02	(-.01 - .05)	.07	(-.08 - .21)
Socio-demographic variables											
	Time	.03	(-.03 - .09)	.05*	(.00 - .10)	<.01	(-.05 - .04)	-.01*	(-.02 - -.00)	.09*	(.00 - .18)
	Gender (ref. cat. male)	.10	(-.00 - .21)	.08**	(.03 - .14)	.10***	(.04 - .15)	-.01	(-.03 - .01)	.15**	(.04 - .26)
	Education – secondary with maturita	.09	(-.04 - .22)	-.02	(-.09 - .04)	.14***	(.07 - .20)	-.03	(-.05 - .00)	.08	(-.06 - .22)
	Education – tertiary	.08	(-.08 - .23)	-.02	(-.11 - .06)	.25***	(.17 - .33)	-.04*	(-.07 - -.01)	.14	(-.02 - .30)
	Age	.01**	(.00 - .02)	<.01	(-.01 - .00)	-.02***	(-.02 - -.02)	<-.01**	(-.01 - -.01)	.01*	(.00 - .01)
	Household income	.13***	(.10 - .17)	.01	(-.01 - .03)	.04***	(.02 - .05)	<.01	(-.01 - .00)	.12***	(.08 - .16)
	Economic status (ref. cat. employed)										
	Self-employed	.05	(-.18 - .28)	-.09	(-.21 - .03)	.05	(-.07 - .16)	.02	(-.02 - .05)	.01	(-.23 - .25)
	Unemployed	-.31	(-.65 - .03)	-.21*	(-.39 - -.03)	-.27**	(-.44 - -.09)	-.05	(-.12 - .03)	-.12	(-.47 - .23)
	Student	.55***	(.26 - .83)	.16*	(.01 - .31)	.22**	(.08 - .37)	-.10***	(-.16 - -.04)	.45**	(.16 - .75)
	Retired	.06	(-.15 - .26)	<.01	(-.11 - .11)	-.20***	(-.31 - -.10)	-.10***	(-.15 - -.05)	.20	(-.01 - .42)
	Maternity leave	.25	(-.07 - .57)	-.03	(-.20 - .13)	-.03	(-.20 - .13)	-.10**	(-.17 - -.03)	.01	(-.32 - .34)
	Number of children below the age of 5										
	One child	.18	(-.03 - .40)	.02	(-.09 - .13)	.08	(-.02 - .18)	.01	(-.02 - .04)	.38***	(.17 - .59)
	Two or more children	.41*	(.07 - .75)	.08	(-.11 - .26)	.18*	(.01 - .34)	-.01	(-.07 - .05)	.40*	(.05 - .76)
Constant		4.47***	(3.82 - 5.12)	2.74***	(2.39 - 3.10)	2.71***	(2.38 - 3.04)	.50***	(.37 - .63)	4.36***	(3.67 - 5.05)
	Observations	4,523		3,850		3,867		2,097		3,857	
	Households	2,155		2,100		2,105		1,305		2,101	
	AIC	17464		9538		8962		-64		14604	
	BIC	17625		9694		9118		77		14754	
	ICC households	14%		7%		5%		3%		10%	
	ICC individuals	70%		87%		85%		95%		88%	
	ll	-8707		-4744		-4456		56.91		-7278	

Note: *** p<0.001, ** p<0.01, * p<0.05, 95% CI in parentheses

The effects of sleep duration on subjective health (B = -.045, p = .001) and happiness (B = -.084, p = .003) were statistically significant at the between-person level. Sleep duration was not a statistically significant predictor of life satisfaction (B = -.021, p = .436), wellbeing (B = -.013, p = .364) or work stress (B = -.005, p = .424) at the between-person level. At the within-person level, the effects of sleep duration were not a statistically significant predictor of happiness (B = -.044, p = .405), wellbeing (B = .028, p = .335), subjective health (B = -.020, p = .412), work stress (B = -.022, p = .110) or life satisfaction (B = -.007, p = .890).

The effects of sleep quality on life satisfaction (B = .653, p < .001), wellbeing (B = .463, p < .001), work stress (B = -.043, p < .001) subjective health (B = .468, p < .001) and happiness (B = .742, p < .001) were statistically significant at the between-person level. At the within-person level, the effects of sleep quality were a statistically significant predictor of life satisfaction (B = .149, p = .036), wellbeing (B = .183, p < .001), subjective health (B = .143, p < .001) and happiness (B = .283, p < .001), but not of work stress (B = -.009, p = .612).

The effects of social jetlag on life satisfaction (B = -.086, p = .040) and work stress (B = .017, p = .020) were statistically significant at the between-person level. Social jetlag was not a statistically significant predictor of happiness (B = -.083, p = .052), wellbeing (B = -.019, p = .378) or health (B = -.032, p = .125) at the between-person level. At within-person level, the effects of social jetlag on life satisfaction (B = .105, p = .136), wellbeing (B = .032, p = .433), work stress (B = .017, p = .296), happiness (B = .068, p = .352) and health (B = .059, p = .087) were not statistically significant.

Discussion

The Czech Republic (CR) is comparable to other European countries in standard of living. The CR is on average commensurable with other European countries in life expectancy and economic activity [54] and self-perceived health [55]. While the life satisfaction score in the CR is very close to the European average, Czechs are slightly less happy, their happiness score being comparable to European countries such as Portugal, Italy and Greece [56]. The average sleep duration in the CR is 7.5 hours (see Data and methods section), which is similar to other European countries such as Belgium, France, Hungary, the Netherlands and the United Kingdom [57]. The proportion of Czechs (31 %) with social jetlag is also comparable to the European average [15]. However, although Czechs

report around 49 minutes of social jetlag (see Data and methods section), Spaniards and Germans report longer times [58]. The source of this difference is unclear, but it is probably because the samples are non-representative. It may be also the result of distinct cultural and environmental contexts or locations. In summary, the CR represents a case study of a population with living standards, QoL and sleep patterns are comparable to other European countries. The findings of the present study can therefore be reasonably generalized to other countries.

Building on IQOL theory and previous studies, the present study expands on the relationship between QoL and sleep. It contributes to the existing literature by examining the main areas of life and sleep from representative panel data to form a better understanding of how sleep and QoL are intertwined and the development of their relationship over time. The results of this study do not support the hypothesis (H1B) that QoL increases when people change their sleeping habits to spend more time sleeping. However, the results agree with previous studies which report a relationship between sleep duration and QoL [18,21] from results which show differences between people in their perceived health and happiness according to the number of hours they spend sleeping (H1A). Individuals who spent more time sleeping also reported worse subjective health and lower levels of happiness. The negative association between subjective health and sleep duration may be a result of long-term stress or mental illness which have affected their sleeping habits since previous studies have shown that individuals with poor mental health and depressive symptoms report sleeping issues and also longer sleep duration [59]. The negative association between sleep duration and QoL agrees with previous findings [2,18,21].

In accordance with our hypotheses (H2A and H2B) and previous studies, sleep quality was found to be a robust and reliable predictor of QoL [1,29,30]. Our analyses show individuals who experience higher quality sleep also have greater satisfaction with life, more wellbeing, feel healthier, perceive less work stress and are happier (H2B). With changes over time, a positive association between improvement in quality of sleep and increase in life satisfaction, wellbeing, subjective health, and happiness is evident (H2A). The overall positive effect of change in sleep quality on QoL agrees with previous research [1,10,28,30]. The only indicator not associated with a change in sleep quality is work stress, perhaps due to the complexity of the link between these indicators. A mediator variable which also captures emotional aspects, such as workplace relationships, might be missing [21].

These results also contribute to the ongoing debate regarding the ambiguous consequences of social jetlag on our lives. Our results agree with Jankowski [34] and Önder [26] are contrary to Chang and Jang [35]. Our hypothesis (H3A) that individuals with a higher level of social jetlag are less satisfied with life and experience a higher level of work stress than others was only partially confirmed. Our findings do not suggest any association between social jetlag and wellbeing, subjective health or happiness. Furthermore, a change in social jetlag has no effect on any measured QoL aspect (H2B). This may be due to social jetlag being relatively stable, as it is likely to change only as a consequence of a relatively major life change (new job, birth of a child) which results in a new sleep schedule. Therefore, individuals with less sleep debt experience a minor increase in various aspects of QoL, but individuals with more social jetlag stagnate, apart from experiencing a decrease in work stress. Since these changes are not very frequent, social jetlag has a low variation over time, leading to the absence of a longitudinal effect, except in work stress, which is most likely related to changes in employment arrangements.

The results of the present study are consistent with previous studies [1,22,28] and suggest a strong relationship between sleep quality and QoL and a rather limited effect of sleep duration or social jetlag on QoL. A comparison of the respondents' sleep quality indicated a slight improvement in happiness in those who experienced poorer sleep during the last wave (2020) of data collection. This may have been caused by an overall increase in sleep quality triggered by social lockdowns designed to suppress Covid-19. Poor sleepers also indicated a small decline in work stress, perhaps because of more flexible working arrangements experienced early during the Covid-19 pandemic. Longitudinal effects nonetheless remained stable over the previous three years, as we presumed.

The results of this longitudinal study provide an important insight into people's lifestyles. Despite people having different sleep requirements, the results suggest that both average sleep duration and social jetlag remain moderately stable over time. Sleep quality is also a valuable subjective measure related to other factors which encompass several important areas of life, such as mental and physical health, emotional wellbeing, cognitive functioning and feeling of safety.

Limitations

The strengths of our study are longitudinal design, differentiation of between-person and within-person effects and the advantage of a representative dataset which enabled the

incorporation of all three aspects of sleep (quantity, quality, social jetlag) into a single model. This is also the first study which has tested the longitudinal effect of social jetlag on QoL. Admittedly, the study also has limitations. First, the period of measurement is relatively too brief to allow stronger claims regarding the longitudinal effect of sleep. Second, all the results are correlational. Using panel data does not qualify for asserting causal claims, and therefore it is not possible to state, for example, whether people feel less healthy because of low quality sleep or whether low-quality sleep leads to poorer health. Third, even though the CR is comparable to other European countries in living standard and sleeping habits, this is a case study of a single country. Having the opportunity to test our findings in other countries would be a great venue for future research. Fourth, the sleep indicators are self-reported and therefore have limitations despite self-reported measures being similarly reliable predictors [60]. Ideally, the measures would be collected in a medical lab or via mobile devices to aid in cross validating our results with more objective methods of measurement. Fifth, even though data were collected on regular days, the final wave partially captured the experience of the pandemic in the spring of 2020, and this study, therefore, might not be representative of the behavior under normal circumstances. However, data collection occurred during periods of eased restrictions and likely did not affect the generalizability of the results.

Conclusion

The present study delivers a comprehensive analysis built on previous studies to extend knowledge on the role of sleep in life. In measuring three distinct facets of sleep in a single longitudinal model, sleep quality was found to be the most influential factor affecting the five aspects of QoL (wellbeing, life satisfaction, subjective health, work stress and happiness). Individuals who experienced more quality sleep also reported better QoL. Improvement of sleep quality over time is also related to improvements in QoL. Sleep duration and social jetlag are also somewhat related to QoL, but in contrast to sleep quality, these factors do not appear significant. The study suggests, with the exception of extremes, that sleep duration alongside the differences in sleep habits on workdays and free days is not as important to QoL as what is considered a good night's sleep. Sleep is vital to our functioning. Changes in lifestyle and psychological challenges which have either emerged or been amplified under the currently ongoing pandemic have undoubtedly affected sleeping habits. That topic, preferably in a study involving multiple

points over time for a long-term comparison and sleep at non-standard times such as Covid-19 pandemic, will be the focus of future research.

4. Social jetlag: work and family correlates

Abstract

By definition, social jetlag – a misalignment between the social and biological time – is closely linked to social obligations that conflict with the individual's chronotype. It is a widespread phenomenon and is linked to various negative health, cognitive, and psychological outcomes. Although there are studies on social jetlag, they are mostly dominated by biomedical approaches. Therefore, the presented study aims to explore the link between social jetlag and work and family status from an original social perspective. The study explores the link between the magnitude of social jetlag and factors related to the type of occupation and selected family obligations using a representative Czech sample. Using the 4th wave of the Czech Household Panel Survey (CHPS), secondary data analysis in Stata 16 was performed. A sample of 1,441 employed and self-employed respondents was included in the analysis. The multilevel mixed-effects modelling was used to control for members of the same household. Model fit was evaluated by likelihood ratio test and BIC. Self-employed individuals are less likely to experience social jetlag than employees. Professional classes are least likely to suffer from social jetlag. Lower occupational classes experience more severe social jetlag, but its severity is moderated by self-employment. If self-employed, the routine manual and non-manual workers do not experience significantly larger social jetlag than professionals. In contrast to occupation, we found no evidence that family status, such as co-residential partnership, contributes to the severity of social jetlag. Working parents of small children experience lower social jetlag than childless individuals. In conclusion, our results demonstrate that social jetlag is more closely linked to the type of work than to the family status.

Keywords: *employment; occupations; self-employment; social jetlag; work & family*

Introduction

The impact of increasing time pressure, accelerating rhythms of daily life, and the ensuing 'sleep deprivation epidemic' have attracted considerable attention in recent decades (Chatzitheochari – Arber 2009; Lyon 2019; Schieman – Glavin 2016). This increasing social pressure not only causes sleep deprivation but also changes the temporal organization of our life causing misalignment between individual biorhythm and daily

schedules within the 24-hour period. The individual biorhythm is driven by the endogenous time-keeping (circadian) system that entrains the solar day (Roenneberg et al. 2019). Humans are diurnal, being active during the light phase and sleeping during the dark phase, but the time when we prefer to sleep and be awake relative to the social time greatly varies in populations, and has been described as a chronotype (Borisenkov et al. 2019; Roenneberg – Merrow 2016; Roenneberg et al. 2019). Although an individual chronotype is partly affected by social factors, there is a significant biological component (Nobs et al. 2016; Nováková et al. 2013; Zhang et al. 2016). A widely used and validated tool, the Munich ChronoType Questionnaire (MCTQ), has been employed to determine chronotype distribution in large population samples, and data demonstrated that chronotype exhibits almost normal distribution with small over-representation of late over early chronotypes (Roenneberg 2007; Roenneberg et al. 2019). Importantly, the same distribution was recently confirmed for the Czech population examined in this study (Sládek et al. 2020).

Social jetlag mostly occurs when evening types need to conform the beginning of their activity to early hours and morning types need to extend their activity schedules into later hours (Roenneberg et al. 2012; Wittmannet al. 2006). Importantly, social jetlag cannot be equated with sleep deprivation produced by short sleeping hours as even those with adequate sleep duration might suffer from social jetlag (Konrad S. Jankowski 2017). In contemporary society, social jetlag is a widespread phenomenon. About 80% of the population uses an alarm clock on workdays (Foster et al. 2013; Roenneberg et al. 2013) signalizing the misalignment of biological and social time. Empirical studies suggest that 70% of the adult population suffers from at least one hour of social jetlag (Roenneberg et al. 2012; Roenneberg et al. 2007; Rutters et al. 2014; Wittmann et al. 2006). It is believed that social jetlag has a major impact on physical and mental health, work productivity, academic outcomes, substance abuse, cognitive performance, and other life outcomes (Beauvalet et al. 2017; Díaz-Morales – Escribano 2015; Haraszti et al. 2014; Haynie et al. 2018; Lang et al. 2018; Levandovski et al. 2011; Rutters et al. 2014; Smarr – Schirmer 2018; Tavares et al. 2020; VoPham et al. 2018). With rare exceptions (Cheng – Hang 2018; Hulsegge et al. 2019), research on social jetlag has been dominated by biomedical approaches. Yet, social jetlag is – by definition – closely linked to social obligations that conflict with the individual's chronotype. In this article, we raise the questions of whether and how the type of work and family status contribute to social jetlag. In particular, we formulate several hypotheses that social class, employment status, the number of working

hours, and commuting times are likely predictors of social jetlag and its severity. Furthermore, even though the temporal organization of the labour market is the most obvious determinant of social jetlag (Barber – Jenkins 2014; Ikeda et al. 2020; Schieman – Young 2013; Virtanen et al. 2009), it is plausible to expect that unpaid work in form of housework, childcare, and other family obligations also affect sleep timing (Barnes et al. 2012). Therefore, using the fourth wave of the Czech Household Panel Survey we test a hypothesis that work-family conflict may result from a time-based conflict.

Literature Review and Hypothesis Development

We suggest that social class is an important predictor of social jetlag as it is closely linked to the degree of autonomy and the extent to which work may be monitored and controlled by the employer (Evans 1992; Harrison – Rose 2006). By the definition, the work of professional and service classes is governed by a service contract. The employment relationship is not defined by particular tasks but by a more diffuse exchange that provides the worker with relative autonomy, flexibility, and discretion about the job assignments (Erikson – Goldthorpe 1992). Moreover, the professionals and service classes tend to have jobs that are less connected to a particular time and place. Thus, it is plausible to expect that higher flexibility and autonomy of professional and services workers provide more opportunities to adjust their schedules and working times to their chronotypes. In contrast, the employment relationship between routine non-manual and manual workers is regulated by labour contracts. Their work is defined by particular tasks and their wages are calculated on a 'piece' or time basis (Erikson – Goldthorpe 1992). As these tasks tend to be related to a specific time and place, the level of flexibility is lower, and routine non-manual and manual workers might be more likely to suffer from social jetlag.

Hypothesis 1: Professional and services classes are less likely to suffer from social jetlag than routine manual and non-manual classes.

In addition to social class, we consider the number of hours spent in employment also matter. Several studies demonstrated that long working hours are negatively linked to sleep quality and duration (Afonso et al. 2017; Knutson et al. 2010). We suggest that long working hours might be linked to misalignment between individual biological time and the actual timing of sleep. First, very long working hours might extend to what would be the preferred sleeping times. Individuals with early chronotypes might be forced to work late into the night while those with later chronotypes might need to start their work earlier

than would be their preference. Indeed, there is evidence that long working hours are associated with increased job involvement and communication outside of the standard working schedules (Schieman – Young 2013). Long working hours might also affect the severity of social jetlag indirectly. Spending more hours at work pushes other activities, such as family and personal time, into the early or late hours.

Hypothesis 2: The longer the working hours and commuting times, the higher level of social jetlag.

Self-employment is likely to be a major predictor of social jetlag. Self-employed individuals generally tend to have higher work flexibility and the desire for more autonomy might be an important motivation for self-employment (Dawson – Henley 2012; Nordenmark et al. 2012). Thus, it is plausible to speculate that the self-employed are more likely to adjust their work schedules according to their chronotype and experience lower values of social jetlag. At the same time, it is necessary to consider the heterogeneity of self-employment. Treating the self-employed as a homogenous group conflates entrepreneurial ventures with the more precarious forms of self-employment (Glavin et al. 2019). As self-employment among non-professional classes tends to be more precarious, they might not be able to enjoy as much flexibility as those from professional classes.

Hypothesis 3: Self-employed individuals are less likely to suffer from social jetlag as they have more freedom to adjust their schedules to their time preferences.

Hypothesis 4: Self-employed individuals are heterogeneous groups. The link between self-employment and social jetlag is weaker among non-professional classes. Self-employment tends to be less advantageous and more precarious in these social groups.

Work is not the only life domain that exerts pressure on an individual's finite time resources. The time devoted to unpaid household work also increases the pressure on the individual's schedules and might contribute to social jetlag. Theoretically, social jetlag could arise from the difference between parent and child chronotypes. It is because small children, in general, are inclined toward morning chronotypes (Caci et al. 2005; Randler et al. 2009). Although partial heritability of chronotype has been suggested (Hur 2007; Klei et al. 2005; Von Schantz et al. 2015), there is also evidence that chronotypes in the family often mismatch (Pereira-Morales et al. 2019). Additionally, there are also studies on the parent-child synchrony, which, however, often have considerable limitations, such as sample size (Leonhard – Randler 2009). There is also no doubt that childcare is one of the most time-consuming activities and the presence of young children decreases sleep,

as discretionary time (Burgard – Ailshire 2013) and sleep is considered to be a victim of competing demands of work and family (Barnes et al. 2012). This means that sleeping patterns are most likely to be disrupted if children are small and parents work full time. This is true particularly for women who are responsible for the lion's share of housework and childcare (Hamplová et al. 2019).

In spite of this, studies in parents of young children showed that their chronotype adjusts according to their children's because it becomes earlier than that of childless age-matched subjects (Caci et al. 2005; Feldman 2006; Sládek et al. 2020; Yamazaki 2007). This effect was significant not only for the sleep phase (based on MCTQ) but also for subjective assessment of the best alertness time (Sládek et al. 2020). Therefore, taking care of small children may not increase the size of the social jetlag.

Hypothesis 5: Taking care of young children will not increase social jetlag.

Hypothesis 6: The effect of young children at home is stronger for those working full-time, particularly for mothers.

Data and methods

Design of the Study, Dataset, and Participants

The Czech Household Panel Survey (CHPS) is a nationally representative longitudinal survey. The households were selected by a two-stage stratified probability sampling design. Information on respondents' sleeping patterns was collected in Wave 4 (2018) Detailed technical information is available in Czech Social Science Data Archive (Kudrnáčová 2019) and the data are publicly available both in Czech and English.

Since we are interested in the harmonization of work and family in the context of social jetlag, only currently working (employed and self-employed) individuals with numerable sleep determinants that filled Pen-And-Paper-Interviewing (PAPI) self-administered questionnaire were are included in the analysis. In total, we were able to analyze information on 1,441 respondents (for descriptive statistics see Table 1). Statistical analyses were conducted in Stata 16 (Stata Corp. 2021). The multilevel mixed-effect approach was adopted due to individuals nested among households: the model, therefore, controls for members of the same household since this aspect, if not controlled for, may otherwise distort the results. To address the research questions, two sets of models were created, both having social jetlag as a dependent variable. The first set (Table 3) focuses

on the effects of job-related characteristics, while the other set (Table 4) adds the lens of a family context.

Model fit is evaluated by likelihood ratio test and by BIC – Bayesian Information Criterion.

Dependent variable

The dependent variable ***social jetlag*** was derived from the Munich ChronoType Questionnaire (MCTQ: WEP 2020) following the example of many previous studies (e.g., Borisenkov et al. 2019; Jankowski 2017; Wittmann et al. 2006). Respondents reported their sleep behaviour over 4 weeks prior to the survey. They were asked about workdays and work-free days separately: a workday was defined as a day with a regular schedule (job, school, work as a housewife/househusband). Then, based on the answers to self-reported questions *"At what time do you usually fall asleep/wake up on workdays/free days?"*, social jetlag was calculated as mid-sleep time on free days (MSF) minus the mid-sleep time of workdays (MSW) and was then converted to a numeric variable holding the absolute value of hours of sleep debt (only 1.81% of the analysed sample suffered from negative social jetlag which represents excess sleep); the result of social jetlag equals zero means no misalignment, values above zero are a sign of social jetlag (accumulation of sleep debt during workdays or free days).

Main explanatory variables

Social class was measured by the European Socio-economic Classifications (ESEC). The variable was derived from the International Standard Classification of Occupations (ISCO-08). The ISCO-08 codes were translated into ESEC using the iscogen module in Stata 16 (Jann 2019). The original ESEC classification consists of nine classes that comprise both occupation and employment status. This article used a reduced 6-category ESEC version for two reasons. First, as we controlled for self-employment in an independent variable, we incorporated self-employed individuals into their occupational groups. Second, only 11 individuals were coded into lower technician occupations, they were included in lower services, sales, and clerical occupations. The transformation produced six following classes: 1) Large employers, higher-grade professional, administrative, and managerial occupations; 2) Lower grade professional, administrative and managerial occupations and higher grade technician and supervisory occupations; 3)

Intermediate occupations; 4) Lower services, sales, and clerical occupations; 5) Lower technical occupations, and 6) Routine occupations. In the analyses, the social classes were reduced to three (see the analytical part) since there were no significant differences between them, and the model with merged classes had improved model fit.

Self-employment is a dummy distinguishing between an employee and the self-employed (including liberal professions).

Working hours is a variable combined from answers to two questions: "How many hours weekly, on average, do you work for pay?" and "How many hours weekly, on average, do you work in any additional paid jobs or other gainful activities?" differentiating between those working less than 40 hours per week, those working 40 hours per week, those working over 40 but less than 50 hours a week, and those working 50 or more hours per week. In a supplementary analysis, we also tested a more detailed categorization of part-time jobs. However, the number of respondents with short part-time jobs was small and there were no major differences between short and longer part-time work.

Commute time was captured by the question "How long does it usually take you to get from home to work, door to door? Include only the one-way trip, and if the duration varies between days, count the average." and it was recorded in minutes. Zero commute time represents work from home.

The respondent's family status is measured with two indicators: partnership status and presence of children in the household. ***Partnership status*** categories distinguished respondents who were single and respondents who lived with a co-residential partner irrespective of the formal marital status. ***The presence of minor children*** in the household was measured with three variables: the presence of a child aged 0-5, the presence of a child aged 6-11, and the presence of a child aged 12 to 17.

Control variables

As social jetlag is linked to individual chronotype and the chronotype changes during lifetime (Jankowski 2015; Paine et al. 2006), all models are controlled for ***age***. In supplementary models, we used a categorical measure of age to test for non-linearity of the relationship (not shown in the article). However, as non-linearity was not detected, age was used as a continuous measure.

Social jetlag is often normalized for ***sex*** (Koopman et al. 2017; Levandovski et al. 2011; Mathew et al. 2019). In this study, we also included sex as a variable because we were interested in the interaction between socio-demographic characteristics and respondents' sex.

Some of the latest studies show that ***municipality size*** is another variable worth noting while examining the misalignment between biological and social time. More inhabited areas have a different character from the smaller ones; since business and administrative centres are often located here, people have less daylight exposure due to spending most of the day inside, but higher artificial light exposure during the night. These factors affect the phase-angle of circadian entrainment towards delaying the internal time (Pilz et al. 2018; Roenneberg et al. 2007; Sládek et al. 2020) and, therefore, contribute to social jetlag. Vice versa, there is a positive correlation between living in the countryside and earlier circadian rhythm (Carvalho et al. 2014).

In a supplementary analysis, we included the parameter Best Alertness midpoint (BAmid), which can be best understood as a self-perceived chronotype that could be a confounder in the analysis (Sládek et al. 2020) and it might serve as a controlling supplementary variable to social jetlag (we report on the limitations of social jetlag within Limitations and Discussion section). Importantly, the employment of BAmid did not affect the main findings obtained by using MCTQ parameters (the supplementary models using BAmid are reported in the Appendix).

Weights

The descriptive statistics are weighted by stratification weights to correct deviations from population proportions in terms of sex, age, region of residence, and distribution of days a week (Kudrnáčová 2019). As for the regression models, no weight was applied (see e.g., Evans ─ Mills, 2000; Grandin et al. 2006).

Results

Descriptive Statistics

The descriptive statistics used within the analyses are reported in Table 1. Due to the nature of our research question, solely the working population is included, all non-working individuals (the unemployed, retired, students, housewives, parents on parental

leaves, etc.) were excluded. As for the socio-demographic characteristics, the sample consists of 46 per cent of men, and the average age of the sample is 45 years. Most people report living with a partner or a spouse in the household, while about one-fourth are single. About 60 percent of respondents live with at least one minor child. One-quarter of respondents live in the big cities, while the density in the smaller municipalities is about the same. As for the employed work characteristics, the higher grade professionals or employers constitute 22 percent of the sample, routine and lower technical occupations represent nearly one-quarter of the sample. Unsurprisingly, most respondents are employees, only about one in 8 respondents were self-employed. About 65 percent of respondents work between 40 to 50 hours per week. Also, commuting is quite usual among the working population, on average, it takes them almost 25 minutes to get to work. As for the misalignment of social and biological time, the sample's average social jetlag is 1.2 hours.

Table 2 shows the distribution of social jetlag in the sample. Higher occupational classes report lower values of social jetlag than lower service workers, lower technical occupations, or routine workers. Self-employed suffer on average from 48 minutes of social jetlag (0.8 hours), while employees experience around 1 hour and 18 minutes of social jetlag (1.3 hours). Even though respondents without a minor child at slightly more likely to report zero social jetlag, the overall difference among individuals with children is negligible. The appendix shows figures with a detailed distribution of social jetlag.

Table 1: Descriptive statistics of the analytical sample

		%
Sex	*Male*	46.2
	Female	53.8
Partnership status	*Single*	26.7
	Partner/spouse in the hh	73.3
At least one child in the hh	*0 to 5 years old*	17.7
	6 to 11 years old	23.4

	12 to 17 years old	21.5
	No child	37.5
		0.0
Municipality size	*up to 999 inhabitants*	15.8
	1 000 - 4 999 inhabitants	18.5
	5 000 - 19 999 inhabitants	18.8
	20 000 - 99 999 inhabitants	20.4
	100 000 inhabitants and more	26.5
European Socio-economic Classification (ESEC)	*Large employers, higher-grade professional, administrative, and managerial occupations*	22.0
	Lower-grade professional, administrative and managerial occupations and higher grade technician and supervisory occupations	21.3
	Intermediate occupations	12.6
	Lower services, sales, and clerical occupations	19.5
	Lower technical occupations	12.1
	Routine occupations	12.5
Self-employed	Yes	12.1
	No	88.0
Weekly working hours	<40	17.3
	40	41.3
	40<->50	23.3
	50+	18.1
Age (years)	(mean ± SEM)	45.1 ± 0.27
Absolute social jetlag (hours)	(mean ± SEM)	1.2 ± 0.02
Commute time (min)	(mean ± SEM)	25.0 ± 0.69

Data are presented in percentages unless the units are explicitly stated. SEM = standard error of mean.
Note: N = 1441, weighted
Source: Czech Household Panel Survey 2018

Table 2: Distribution of Social Jetlag in the Analytical Sample

Sleep duration (hours per night)	Average SJL (hour)	0m	1-30m	31m-1h	1-2h	2h+
Less than 7 hours	1.3	6.3	15.9	20.7	38.0	19.2
7+ hours	1.2	5.7	17.8	23.3	41.3	11.8
Total	1.2	6.5	17.5	22.0	39.0	15.0
Social class						
Higher professionals	1.1	7.2	19.2	29.2	36.0	8.5
Lower professionals, administrative	1.2	4.8	15.5	27.7	42.6	9.4
Intermediate occupations	1.3	4.1	14.4	22.1	45.0	14.5

Lower services, sales	1.5	9.7	21.8	14.9	37.6	16.0
Lower technical occupations	1.5	7.9	15.8	15.4	34.8	26.1
Routine occupations	1.5	3.9	15.9	17.0	39.0	24.2
Self-employed						
No	1.3	5.1	15.8	22.1	40.6	16.4
Yes	0.8	16.8	29.9	21.1	27.8	4.5
The youngest child at home						
None	1.2	8.7	18.9	20.4	34.7	17.3
0-5	1.2	4.6	20.0	21.8	41.9	11.8
6-11	1.3	3.5	14.7	19.6	49.2	12.9
12-17	1.3	4.4	14.6	22.7	44.3	14.0

Data are presented in percentages unless the units are explicitly stated.
Note: N = 1441, weighted
Source: Czech Household Panel Survey 2018

Multivariate Results

Table 3 addresses hypotheses concerning the link between social jetlag and job characteristics. Model 1 entered all control variables (sex, age, and municipality size) and served as a baseline. Among control variables, only the respondent's age was significantly linked to social jetlag. As expected, older individuals were less likely to suffer from the misalignment between biological and social time. This might be partly linked to the shift towards earlier chronotypes as people age (Jankowski 2015; Paine et al. 2006; Taillard et al. 2004).

Model 2 incorporated all work-related variables: social class, employment status, the number of hours worked, and commuting times. Integrating these variables improved the model fit considerably (BIC dropped by 42). Closer inspection of estimates for social class, however, revealed that there was no significant difference between classes 1 and 2 (large employers, higher-grade professional, administrative, and managerial occupations and lower grade professional, administrative and managerial occupations and higher grade technician and supervisory occupations), class 3 and 4 (intermediate occupations, lower services, sales, and clerical occupations) and classes 5 and 6 (lower technical occupations and routine occupations). Thus, we merged these categories. Reducing the number of classes significantly improved the model fit in terms of BIC (by 19) and the likelihood ratio test did not indicate any loss of information (LR chi2 = 2.85; Prob > chi2 = 0.416). Thus, we continued with the more parsimonious Model 3.

Hypothesis 1 predicted that professional and service classes are less likely to suffer from social jetlag than routine manual and non-manual classes. Model 3 fully supported this expectation. Using marginal prediction, we estimated that a typical professional worker (classes 1 and 2) suffered from approximately 1-hour social jetlag (1.09 hours, CI 1.04-

1.16), while those from routine and lower technical occupations (classes 5 – 6) suffered over 1.5 hours of social jetlag on working days on average (1.51; CI 1.42-1.60).

However, Model 3 did not fully collaborate with Hypothesis 2 suggesting that working hours and longer commuting time contribute to social jetlag. First, the coefficient for the commuting time was very small and not significantly linked to social jetlag. In the supplementary models that controlled for the best alertness midpoint, the coefficient for commuting time became significant but substantively stayed very low. As for the number of hours worked per week, the association with social jetlag was non-linear. The data suggest that longer hours meant more severe jetlag. However, those working very long hours (50+ hours per week) seem to suffer from lower jetlag than those working regular 40-hour week. This conclusion holds even if other work characteristics are removed from the model. The negative link between very long working hours and social jetlag is surprising. However, it may be driven by a selection of individuals who spend 50+ hours at work.

Furthermore, Model 3 also tested Hypothesis 3 predicting that self-employed individuals are less likely to suffer from social jetlag. Indeed, using the marginal predictions and keeping other covariates at the mean (see Figure 1), the self-employed experienced on average 0.87 hours of social jetlag on workdays (CI: 0.74-0.99) while the employees suffered 1.27 hours of social jetlag (CI: 1.23-1.32). Model 3 treated the self-employed as a homogenous group. However, in the theoretical discussion, we suggested that the link between self-employment and social jetlag is weaker among non-professional classes (Hypothesis 4). Even though self-employed might be better off on average, non-professional classes might be less likely to take the advantage of the status. To test this hypothesis, we included an interaction between social class and self-employment (Model 4). Even though the BIC of Model 4 slightly increased, the likelihood ratio test suggested that the interaction was significant and improved the model fit (LR chi2(2) = 11.03; Prob > chi2 = 0.00).

Contrary to our theoretical predictions, this model showed that the effect of self-employment on social jetlag was stronger for intermediate and lower technical and manual classes. Hence, it is not the professional classes that benefit from self-employment the most but those with lower status jobs. Figure 1 demonstrates these results in more detail. It shows that employed and self-employed professionals do not significantly differ in terms of social jetlag. Yet, self-employment brings benefits to the non-professionals and particularly lower technical or routine workers. Among these workers, self-

employment offsets all disadvantages concerning the misalignment between biological and social time. In other words, the self-employed manual workers experienced similar social jetlag levels as higher professional classes.

Table 3. Estimated Coefficients From Mixed-Effects Regression With the Dependent Variable Social Jetlag – Testing Work-Related Characteristics

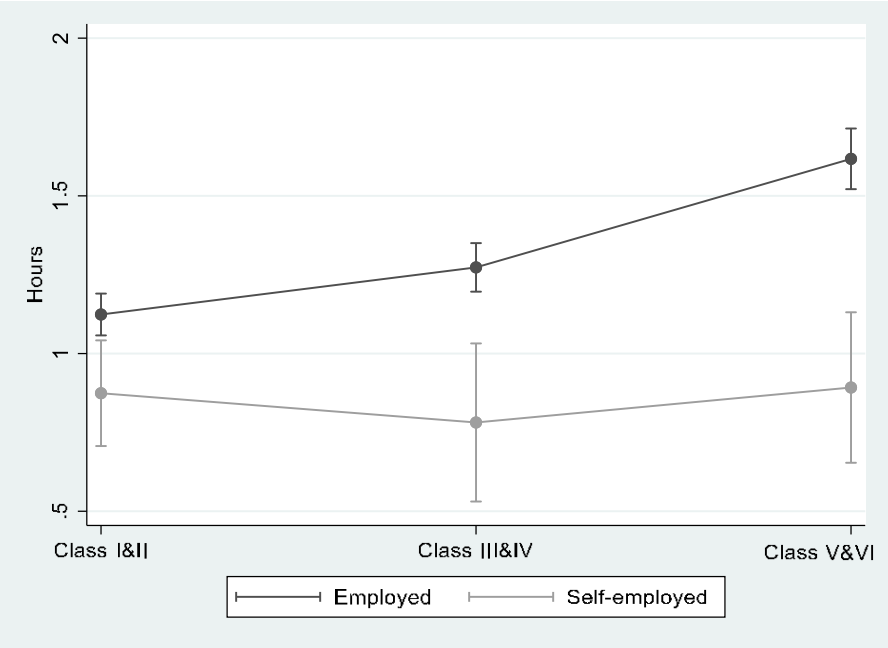
	M1	M2	M3	M4
Age	-0.012**	-0.012**	-0.012**	-0.011**
Sex (*male)*				
Female	0.042	0.082	0.077	0.075
Municipality size	-0.006	0.007	0.005	0.004
Average working hours per week *(< 40 hours)*				
40 hours		0.121*	0.123*	0.124*
41-49 hours		0.181**	0.181**	0.189**
50 hours or more		0.056	0.052	0.052
Commuting time		0.002	0.001	0.001
Self-employed				
Yes		-0.403**	-0.406**	-0.219*
Social class *(I - managers, higher grade professionals, employers, etc.)*				
II - Lower-grade professionals etc.		0.090		
III - Intermediate occupations		0.154*		
IV - Lower services, sales, clerical		0.170**		
V - Lower technical occupations		0.492**		
VI - Routine occupations		0.427**		
Social class *(I-II)*				
Class III-IV			0.119*	0.152**
Class V-VI			0.412**	0.479**
Social class#Self-employed				
Class III-IV#Self-employed				-0.278
Class V-VI#Self-employed				-0.500**
Constant	1.775**	1.423**	1.475**	1.440**
Log-likelihood				
Bayesian information criterion	3512.1	3469.8	3450.8	3454.3

* p<0.05, ** p<0.01

Note: N = 1441

Source: Czech Household Panel Survey 2018

Figure 1. Linear Prediction of Social Jetlag Among Employed and Self-employed Professionals



Source: Czech Household Panel Survey 2018
Note: Adjusted predictions with 95% CIs

The family-related characteristics are analysed in Table 4. Model 1 incorporated controls (age and sex) and family-related characteristics (partnership status and the presence of children of various ages). Hypothesis 5 suggested that the presence of small children in the household is likely not to increase the level of social jetlag which was confirmed in Model 1. Parents with smaller children even have a significantly lesser likelihood to report the misalignment between biological and social time. On average, they reported around 10 minutes lower discrepancy. In contrast, there was no significant difference in the level of social jetlag between those with older children and childless individuals. It may be because chronotype dramatically changes with age - children reaching pubescence turn to more later types. Another possibility is that parents' chronotypes might be already inclined towards morningness due to their age, or the partners' chronotypes are different and so they are more likely to nurture their children without limiting themselves.

Nevertheless, we expected that the family status would interact with the labour force participation, particularly for women, because balancing multiple demands such as housework and childcare along with paid work is demanding (Barnes et al. 2012). In Model 2, all work-related covariates were added, and this model serves as a baseline to address the interactions between work and family domains. Importantly, this model demonstrated that the negative link between social jetlag and the presence of small children remained nearly intact even after controlling for job characteristics. The next three models entered interaction effects into the picture. Model 3 included the interaction

between the presence of at least one small child at home and the number of working hours. Model 4 entered the interaction between respondent's sex and the presence of young children. Finally, Model 5 integrated a three-way interaction between working hours, presence of children, and sex. Surprisingly, none of the interactions was significant, and models with interactions had a significantly worse fit than the baseline Model 3. This conclusion is supported by both BIC and log-likelihood ratios tests (see Table 3).

Table 4. Estimated Coefficients from Mixed-Effects Regression with the Dependent Variable Social Jetlag - Testing Work and Family-Related Characteristics

	M1	M2	M3	M4	M5
Age	-0.014**	-0.014**	-0.014**	-0.014**	-0.014**
Sex (*male)*					
Female	0.027	0.062	0.065	0.046	-0.120
Partner/Spouse at home	-0.119*	-0.078	-0.077	-0.077	-0.071
At least 1 child of age 0-5	-0.151*	-0.152*	-0.210	-0.196*	-0.243
At least 1 child of age 6-11	-0.035	-0.051	-0.049	-0.051	-0.046
At least 1 child of age 12-17	0.061	0.045	0.040	0.046	0.041
Working hours per week *(< 40 hours)*					
40 hours		0.102	0.094	0.107	-0.036
41-49 hours		0.155*	0.102	0.160*	0.002
50 hours or more		0.033	0.043	0.038	-0.115
Commuting time		0.001	0.001	0.001	0.002
Self-employed (no)					
Yes		-0.411**	-0.412**	-0.410**	-0.413**
Social class *(I-II)*					
Class III-IV		0.107*	0.103*	0.105*	
Class V-VI		0.402**	0.404**	0.400**	0.099*
At least 1 child of age 0-5			-0.208	-0.194*	0.400**
At least 1 child of age 0-5#Working hours per week (< 40 hours)					
child#40 hours			0.016		-0.039
child#40-49 hours			0.316		0.207
child#50 hours or more			-0.073		0.025
At least 1 child of age 0-5#Female				0.089	0.056
Female#Working hours per week (< 40 hours)					
Female#40 hours					0.196
Female#41-49 hours					0.141
Female#50 hours or more					0.263
Female#At least 1 child 0-5 of age#Working hours per week					
(< 40 hours)					
Female#child#40 hours					0.115
Female#child #41-49 hours					0.327
Female#child #50 hours or more					-0.273
Constant	1.950**	1.702**	1.724**	1.708**	1.856**
Bayesian information criterion	3516.5	3458.2	3473.6	3464.7	3517.0

For a description of M1 – M5 models, see section Multivariate Result.

* p<0.05, ** p<0.01

Note: N = 1441
Source: Czech Household Panel Survey 2018

Conclusions

In this study, we explored whether the magnitude of social jetlag correlates with work characteristics and family status. Even though social jetlag is closely connected to the temporal organization of social life, studies on its social predictors are relatively rare and nearly all focus on the social jetlag among shift or night workers. Our work shifts the attention towards the general working population. Using data from the Czech Household Panel Survey, we analysed the role of several factors related to work, such as social class, type of employment, working hours, as well as family status, such as parenthood.

We predicted that social jetlag would be systematically connected to social class. In particular, we expected that professional and service classes would experience smaller social jetlag. By definition, 'service relation' is defined by high discretion over work activity and jobs are less connected to a particular time and place. To motivate workers under service contracts, employers tend to create positions with flexible working hours and pay salaries rather than an hourly wage (Evans – Mills 2000). Routine non-manual and manual workers would more likely suffer from jetlag. The employment relation of the wage labour is characterized by less discretion and flexibility. The wages are derived from hours of work, work performed, and extra payment related to contractual bargaining. The trust expectations are low, the work is closely supervised and monitored. Our data fully supported this hypothesis. On average, we estimated that a typical professional suffered from around one hour, while those from routine and lower technical occupations suffered over 1.5 hours of social jetlag.

Furthermore, we hypothesized that social jetlag would be more severe among those with long working hours (Grandin et al. 2006), and longer commute that either contributes to social jetlag directly (Gabud et al. 2015) or is a predictor of shorter sleep (Basner et al. 2007; Chatzitheochari – Arber, 2009) and might, therefore, subsequently contribute to higher social jetlag. However, this hypothesis was not fully corroborated. First, the commuting time contributed very little to the level of social jetlag. Second, the link between the number of hours worked per week and social jetlag was positive but non-linear. Surprisingly, those with very long hours (50+ hours) suffered from low levels of social jetlag. We suggest that this unexpected finding might be attributed to the selection effect. Alternative explanation could be those working excessively overtime work every

day, not distinguishing between workdays and freedays and therefore their social jetlag is minimal.

We hypothesize that the self-employed individuals would typically experience lower social jetlag, particularly those from the professional and service class of occupations (i.e., those with service relations and service contracts, such as managers, technicians, journalists, and educational professionals). This prediction was corroborated only partly. As we expected, self-employment was linked to significantly lower social jetlag. However, in discordance with our hypothesis, it was the routine manual and non-manual classes that benefited most. Researchers often portray self-employment among lower occupational classes as low quality and precarious employment (Conen – Schippers 2019; Glavin et al. 2019). However, our results suggest that self-employment might provide some other types of benefits for routine manual and non-manual classes that are not captured by the standard stratification characteristics. Therefore, self-employment might reduce the misalignment between biological and social time for those who would typically work on labour contracts.

We also tested a correlation between the number of family-related characteristics and social jetlag. Even though by common sense, we would expect that the presence of small children might exert major pressure on schedules if the parent cannot go to bed or cannot sleep because the child needs attention, especially full-time working mothers with small children might suffer from a significant misalignment of social and biological time, previous research shows otherwise. Specifically, based on the previous literature (Antypa et al. 2016; Sládek et al. 2020), we expected that the experience of social jetlag would not be more severe among parents in comparison to childless respondents due to their inclination towards morningness. In accordance with previous literature, we find parents of small children are less likely to experience social jetlag. This finding holds for both mothers and fathers. The parents of both sex at age up to 40 years were earlier chronotype compared to age-matched childless subjects (Sládek et al. 2020). This could be due to a secondary effect of childcare which stems from physiology: mothers and fathers need to get up early with their children and are, therefore, exposed to bright light in the morning which advances their circadian clock (Dijk et al. 1989; Gordijn et al. 1999; Revell et al. 2005). Moreover, according to the MCTQ definition, social jetlag is calculated as a difference in mid-sleep time on free days and workdays but childcare does not necessarily distinguish between them and so the effect is similar on all days. Furthermore, we did not find any evidence that the presence of small children would exert higher pressures on the

sleeping times of full-time employed fathers or mothers. This could be linked to long parental leaves among Czech parents. The overwhelming majority of mothers take three-year-long parental leave. Thus, they would not be working during the period, when the child's and parent's chronotypes are likely to be most misaligned. Only mothers with particularly good working conditions or work flexibility tend to keep working. This means that the selection of parents into employment might explain the lack of effect.

Limitations

The presented article brings an original perspective and we consider it a valuable contribution to the understanding of how work conditions and family situation affect the misalignment between individual chronotype and requirements of social time. There are, however, limitations in this study that could be addressed in future research. Firstly, we are unable to determine causal effects and therefore cannot claim if social jetlag contributes to the choice of work and/or family arrangement or if the work and/or results in the social jetlag. Secondly, all analysed variables are self-reported which necessarily poses a question regarding the subjectivity and accuracy of the measures, especially in the case of social jetlag that should be in an ideal measured via a smart mobile device. Social jetlag, after all, is only an estimation and as such, it suffers weaknesses. Future research should aim to eliminate the mentioned problems and also preferably extend the scope of analysis to more countries and explore the changes in time.

5. Sleep practices among parents and childless individuals

Abstract

While sleep is genetically determined to some extent, it is also largely socially driven. Previous research on sleep is mostly biomedical and inconsistent since the number of analysed sleep variables is limited and it often does not distinguish between genders and parents based on the age of their child/ren. Using representative data from the Czech Household Panel Study (2018) with answers from 2,017 childless individuals and 1,022 parents and employing a method of propensity score matching, the manuscript uses a sociological lens and explores the effect of parenthood on sleep duration on workdays and free days and its effect on social jetlag; misalignment between biological and social preferences. The results show that parents have similar sleep patterns to childless individuals, but mothers, in particular, are deprived of sleep during free days. Childcare for mothers is an equivalent to having an employment seven days a week instead of the average five. Parents' sleep quality is not particularly impaired by the presence of a child/ren in comparison to childless individuals: both rate their sleep as overall rather poor.

Keywords: parenthood, propensity score matching, sleep duration, social jetlag, sleep quality

Introduction

Even though the evidence regarding the overall effect of parenthood on individuals is mixed, the opinion that having children comes at the price of daily strain and lowered well-being is predominant (Nomaguchi and Milkie, 2003). Stress is not the only issue that emerges on becoming a parent. New parents especially, but not exclusively, are often severely sleep-deprived (Hagen et al., 2013), which may further amplify stress and deterioration in their well-being. Very short or very long sleep duration is associated with chronic physical diseases (Chen et al., 2020), and poor sleep quality is associated with higher stress levels and negative moods (Benham, 2021), and both physical and mental health complaints (Pilcher et al., 1997). In addition, a consistent sleep routine is also

important for overall well-being (Bates et al., 2002; Chaput et al., 2020; Fuligni and Hardway, 2006).

Although 46% of the sleep duration and 44% of sleep quality is genetically determined (Kocevska et al., 2021), the rest of the variation is subjected to the environment we live in and is socially driven (Grandner, 2017). Considerable attention has been devoted to the conflict between work and family, but some other aspects of life have been ignored such as sleep (Barnes et al., 2012) despite good sleep habits being a determinant of good health (Chaput and Shiau, 2019; Luyster et al., 2012), physical and mental well-being (Chen et al., 2020; Fuligni and Hardway, 2006; Jean-Louis et al., 2000) and overall quality of life (Groeger et al., 2004). To an extent, sleep is likely to be influenced by the family situation (Barnes et al., 2012) since childcare and related family obligations are time-consuming and demanding. Not only do sleep practices differ among childless individuals and parents, but it is also important to consider the diversity of maternal and paternal experiences (Phares et al., 2005). Even though fathers are more involved in caring for their children than ever before (Cabrera et al., 2000), family roles are still largely gendered: mothers remain more likely to be the primary caregivers, taking parental leave and taking care of the household while fathers are the breadwinners (Fletcher and Bailyn, 2005). This model along with long parental leave for women is practices and also preferred model in the Czech Republic (Robila, 2012).

Despite previous research on sleep and parenthood, the comparisons of childless individuals and parents are lacking in depth and can potentially suffer from selection bias caused by the underrepresentation of parents. Using data from Czech Household Panel Survey, a different perspective is applied: a quasi-experimental design of propensity score matching (PMS) to essentially compare sleep-wake patterns and sleep quality of identical or very similar individuals who differ only on the basis of having or not having children.

The Theory Behind Parenthood and Sleep

The Social Zeitgeber Theory developed by Ehlers, Frank and Kupfer (1988) suggests life events disturb social zeitgebers (social demands), which further disrupt biological rhythms (chronotype), thus resulting in depression and decreased psychological wellbeing. The life event in this case is represented by childbirth, inevitably a significant life change for both parents. The arrival of a baby then results in a change in the social

schedule (childcare responsibilities, work responsibilities, shrinkage of social life) which in turn also affects the biological clock (intermittent sleep, shorter sleep duration).
A growing body of sociological literature on sleep indicates that gendered responsibilities in families influence sleep (e.g., Burgard, 2011; Ruppanner et al., 2021; Venn et al., 2008); since women do most of the household chores and take on the bigger share of childcare, their sleep is more likely to be disrupted than men's' (Maume et al., 2018) and sleep duration and satisfaction among fathers after birth is significantly less pronounced than in mothers (Richter et al., 2019)

Parental Sleep Practices

Sleep Duration

Up until recently, it was presumed that impaired sleep is only an issue for new parents since they attend to the child waking in the night (Byars et al., 2020). However, the existing longitudinal studies show the appearance of insomnia symptoms and a decrease in sleep duration from late pregnancy (Gay et al., 2004; Sivertsen et al., 2015) that persist for up to six years after the birth (Richter et al., 2019). The breaking point of increased sleep deprivation and fragmentation is childbirth, but the sleep situation remains challenging for approximately a year after that due to caregiving demands, especially night-time care (Gay et al., 2004; Insana, Montgomery-Downs, et al., 2013; Sivertsen et al., 2015). In general, parents of minor children suffer from shorter sleep duration than childless individuals, and the younger the children, the shorter the sleep duration (Hagen et al., 2013): one study suggests that children under 2 were most likely to sleep for only about 5-6 hours per day and children between 2 and 18 years old were still unlikely to sleep for 8 hours a day (Hagen et al., 2013; Krueger and Friedman, 2009); another study shows that having children between 2-5 years old means 9 minutes' less sleep nightly, and every child between 6-18 years of age was found to decrease parents' sleep by 4 minutes (Hagen et al., 2013)
While maternal sleep, especially postpartum (approximately 6-8 weeks from childbirth) has been extensively studied, less attention has been paid to the sleeping patterns of fathers. The existing research suggests the sleep of mothers is more highly fragmented (Insana, Montgomery-Downs, et al., 2013). There are some contradictory results regarding sleep duration: while some claim mothers sleep longer in comparison to fathers

(Insana, Montgomery-Downs, et al., 2013), others argue that mothers spent a longer time awake (Insana et al., 2014).

During both the prenatal and postpartum periods, the paternal sleep routine also changes (Condon et al., 2004). As with the mothers, fathers were also found to sleep less, with more disturbances occurring when compared to the late pregnancy period (Gay et al., 2004). When comparing sleep duration between parents, contrary to what one would expect, mothers were found to have significantly longer sleep (401 min) than fathers (330 min) (Meltzer, 2008). However, this study, conducted among parents of children with autism spectrum disorder, did not distinguish between free days and workdays and was conducted on a small sample of 35 mothers and 22 fathers in the US.

Catherine Leonhard and Christoph Randler (2009) explored amounts of sleep among childless women, pregnant women, mothers and pregnant mothers but did not find any statistical differences.

Social jetlag

Circadian rhythm encompasses a time period of approximately 24 hours and governs our preferences sleep and wake cycle. Individuals incline towards morningness or eveningness based on peaks of activity (Adan et al., 2010). However, the preferences based on an individual's biological rhythm often do not match actual behaviour, which is determined by social constraints. This misalignment between biological and social needs and preferences is called 'social jetlag'. Parents may be anywhere on the chronotype spectrum, with the likelihood of being a morning chronotype increasing with age (Jankowski, 2015). As for the mothers, disrupted sleep during pregnancy is quite common (Sloan, 2008), and it can potentially affect maternal circadian rhythm (Hofstra and de Weerd, 2008). The circadian rhythm of infants is diametrically opposite to that of their adult counterparts: it only appears during the first two months of their life, and they have different needs regarding sleep (Joseph et al., 2015). Since small children are not susceptible to social influences but tend to be subordinate almost exclusively to their biological rhythm, overall they are most likely inclined to be morning types (Randler et al., 2009). Even though one would expect that parents' chronotypes and their children's differ, and parents might therefore manifest higher social jetlag, previous research suggests the opposite (Feldman, 2006; Sládek et al., 2020; Yamazaki, 2007). The most recent paper exploring the social jetlag effect among employed adult individuals due to

work and family commitments (Kudrnáčová and Hamplová, 2022) shows, in agreement with the afore-mentioned studies, that parents with smaller children are significantly less likely to experience a misalignment between biological and social time.

Also, the majority of the past studies on social jetlag are discussed in the context of specific groups, such as adolescents (e.g., Díaz-Morales & Escribano, 2015), or nightshift workers (e.g., Roenneberg & Merrow, 2016). Social jetlag research in the context of parenthood, however, is scarce and the existing studies present it only as secondary findings (e.g., Sládek et al., 2020).

Sleep quality

When considering the altered sleep duration and amplified social jetlag among parents, it is not surprising that sleep quality may also change. Pregnancy and childbirth itself are complex physiological phenomena that, according to some, affects mothers' sleep significantly. In comparison, paternal sleep quality changes are less pronounced (Richter et al., 2019). However, some research suggests it is the other way around (Meltzer, 2008). There are records of maternal sleep satisfaction already decreasing three years before childbirth and perceptibly even more shortly after, while paternal sleep quality was found to slightly increase before childbirth (Krämer and Rodgers, 2020). Postpartum mothers predominantly engage in night-time childcare, causing more fragmented sleep and a decrease in their sleep quality according to some (Gay et al., 2004; Richter et al., 2019). A study exploring sleep quality in parents 10-12 weeks postpartum found a slight improvement (Dørheim et al., 2009; Insana, Williams, et al., 2013). Parent studies with 6-months olds that found no difference between mothers and fathers and also mothers and childless women, only fathers were reporting worse sleep quality than control men (Kenny et al., 2021), or studies suggest that mothers' sleep satisfaction steadily increases since giving birth to reach the point where there is no difference between childless women and mothers five years (Krämer and Rodgers, 2020) or even six years (Richter et al., 2019) after the delivery. By contrast, fathers' sleep is said to remain constant over the course of five years after the delivery (Krämer and Rodgers, 2020) or decrease but much less dramatically than for mothers (Richter et al., 2019).

The quality of sleep seems to be closely tied to the parental experience: on the one hand, some articles suggest first-time mothers are likely to have higher quality sleep than experienced mothers (Kenny et al., 2021); on the other hand, other studies report either

no effect whatsoever of first childbirth on parents' sleep patterns when employing PSM (Krämer and Rodgers, 2020) or contrarily suggest first childbirth (Richter et al., 2019) or even the first three childbirths impact negatively on sleep satisfaction among parents, with mothers being likely to suffer from significantly worse quality sleep than fathers (Krämer and Rodgers, 2020).

Summary of the Previous Literature

Even though maternal sleep profiles are quite well described, sleep research is generally more often conducted solely on female samples (Dørheim et al., 2009; El Ansari and Stock, 2010; Leonhard and Randler, 2009). Parental sleep is not sufficiently explored. Barely any sleep studies have taken into consideration childless people as well as parents (Insana, Montgomery-Downs, et al., 2013; Kenny et al., 2021; Krämer and Rodgers, 2020). Moreover, some of the sleep research focuses on a specific population such as parents with children with autism spectrum disorder (Meltzer, 2008). Previous research consists of small samples of dozens or tens (Condon et al., 2004; Gay et al., 2004; Insana et al., 2014; Insana, Montgomery-Downs, et al., 2013; Kenny et al., 2021) which is too small to be reliable, only a minority can be considered representative (Krämer and Rodgers, 2020; Krueger and Friedman, 2009; Kudrnáčová and Hamplová, 2022; Richter et al., 2019) and some of the representative studies were conducted on an employed population which also includes parents (Hagen et al., 2013; Kudrnáčová and Hamplová, 2022). Michael D. Krämer and Joseph Lee Rodgers (2020) employed PSM in their article but they focused on the effect of childbirth on life satisfaction and included only one sleep variable, sleep satisfaction, in their analysis.

Overall, the previous literature on sleep among parents is often contradictory, focuses predominantly on pregnant women or parents of small children and explores a limited number of sleep variables. The current study, therefore, offers a comprehensive description of parental sleep with children of various ages in the household and distinguishes between childless people and parents, also between men and women based on PSM to eliminate selection bias.

Hypotheses

H1: The younger the children, the lower the sleep duration of both mothers and fathers.

H2: Sleep duration differs between free days and workdays.
H3: Parents, in general, are more likely to have less sleep variability in the sense of sleep onset and sleep end during workdays and free days and hence lower social jetlag than childless people in general.
H4: Both mothers and fathers have lower subjective sleep quality in comparison to their childless counterparts.
H5: The older the children, the less the difference in sleep quality between parents and childless individuals.

Data and Methods

Study Design and Participants

The study draws on data from the Czech Household Panel Survey (CHPS), which is a nationally representative sample survey repeatedly interviewing a random sample of households in the Czech Republic since 2015. A method of two-stage stratified random sampling was used and data was collected through Standardized interview face-to-face - computer-assisted personal interviewing (CAPI), paper-and-pencil self-administered questionnaire (SAQ) and computer-assisted web interviewing (CAWI).
The fourth wave of CHPS (2018) was analysed for this study since it contains various sleep measures according to the Munich Chronotype Questionnaire (MCTQ; WEP 2020). The data for this wave were collected between 20th June and 15th October, and a total of 3,188 households were interviewed with a household retention rate of 86.4%. The overall analytical sample after listwise deletion consists of 3,039 respondents in total (2,017 childless individuals and 1,022 parents).
Dataset and complete technical information are available in the Czech Social Science Data Archive (refer to Kudrnáčová 2019).

Treatment and Outcome Variables

Treatment Variables: Parenthood

To discriminate between parents and childless individuals, binary indicators (also called outcome variables) are used. Zero value stands for non-parents, and one represents parents based on the age category of their child/ren. Based on both the theoretical framework and the available variables in the dataset, there are three categories: parents

with at least one child aged ≤ 5, parents with at least one child aged ≥ 6 and ≤ 11 and parents with at least one child aged ≥ 11 and ≤ 17.

Outcome variables: Sleep

Social jetlag

The measure of **social jetlag** was computed according to MCTQ (WEP 2020) as a mid-sleep difference on free days and workdays. The resulting continuous-time variable was converted into an absolute numeric variable representing the hours of social jetlag. Any value above zero represents the discrepancy between social and biological time, whereas zero means the absence of such misalignment. This measure was also employed in other studies (e.g., Jankowski, 2014).

Sleep duration

The total amount of sleep obtained was also incorporated into the analysis as one of the outcome variables. Items "At what time do you usually fall asleep on workdays/free days?" and "At what time do you usually wake up on workdays/free days?" were used to compute the average daily **sleep duration**. As with social jetlag, sleep duration was calculated as a time variable and converted into a numeric variable holding the number of hours. This measure was also employed in other studies (e.g., Sládek et al., 2020).

Sleep quality

The **quality of sleep** is a subjective measure obtained through the question "How would you rate the quality of your sleep?" with responses ranging from 1 to 4 ("very bad", "bad", "good" and "very good"). This measure was also employed in other studies (e.g., Ness & Saksvik-Lehouillier, 2018).

Statistical Analysis

The PSM is used to estimate the effect of parenthood on sleep. It is a statistical procedure that reduces selection bias by a sample compilation in which the confounders are balanced between the groups. It has similar features to an experiment: there are two groups, one control and one treatment. This method allows the assessment of social jetlag, sleep duration and sleep quality among childless individuals and parents. Individuals without

children and parents are matched: a propensity score is calculated based on a set of control variables to achieve the maximum possible similarity so that childless people and parents differ only on the basis of having or not having children.

Firstly, the propensity score is estimated using a logit specification. Secondly, a matching algorithm is used to find the most similar pairs in the sample. Previous studies suggest significant differences between men and women and also among parents based on the age of their child/ren. It is therefore appropriate to create the respective number of propensity score models, which are six in total. For each of them, the most fitting matching algorithm must be used. A variety of matching algorithms was tested but the most applicable ones are listed in Table 1.

Table 1. Propensity score matching algorithms used in analyses

Matching group properties (control group vs. treatment group)		Matching algorithm
Childless people vs. parents with child/ren aged ≤ 5 years	Male	Nearest neighbour 2 matching with replacement
	Female	Nearest neighbour 1 matching with replacement with caliper width 0.002
Childless people vs. parents with child/red aged ≥ 6 and ≤ 11 years	Male	Nearest neighbour 1 matching with replacement
	Female	Nearest neighbour 1 matching with replacement with caliper width 0.0004
Childless people vs. parents with child/ren aged ≥ 11 and ≤ 17 years	Male	Epanechnikov kernel matching with bandwith 0.06
	Female	Nearest neighbour 1 matching with replacement

Also, common support is assessed both subjectively by examining the graphs of propensity scores across treatment and control groups (not presented in the article) and objectively by implementing it into the analyses. The common support condition ensures an overlap between the treatment and the control group, thereby guaranteeing comparability (Caliendo and Kopeinig, 2008).

The outcomes of the matched treatment and the control group are compared in a weighted non-parametric mean comparison to estimate the average effect of being a parent compared to the situation of not being a parent. Standard errors were bootstrapped with 1000 repetitions because the methodological research indicates that bootstrapping performs effectively in PSM (Bodory et al., 2020). The analyses were performed using the Stata psmatch2 command (Leuven and Sianesi, 2003).

Control Variables

Control variables include continuous age (18-70), categorical net household income (1 “up to 29 999 CZK”, 2 “30 000 - 39 999 CZK”, 3 “40 000 - 49 999 CZK” 4 “more than 50 000 CZK”) and education (1 “Primary and secondary”, 2 “Tertiary”).

Since men and women have separate models, the sex variable was not added. Even though in the exploratory models, the couple variable explained parenthood quite well, it was not included in the final models because the vast majority of parents were either married or living with their spouse. This variable has lost its distinctiveness and was therefore eliminated.

Results

Descriptive Statistics and Control Variables Balancing

Tables 2 and 3 show the balancing of control variables before and after matching. Because the analyses are performed separately for the three-parent categories based on the age range of their child/ren and individually for each gender, there are six tables in total. Since the trends are similar among all of them, only two are described in detail below; the other four tables are provided in the supplementary material. It was not necessary to consider different outcome variables because the balancing is the same regardless of social jetlag, sleep duration on free/workdays and sleep quality.

Table 2 indicates substantial differences between the childless and fathers of the youngest child group, especially in terms of age: before matching, the mean age of fathers was 38 while for the control group of the childless, it was 49. Fathers have on average higher education and higher household income. After successful matching, however, the control variables are balanced; standardized percentage bias is reduced to below the recommended value of 5.0, and the variance ratio reaches slightly over 1.0 (Gangl, 2015), representing an equal variance in the control variable for both groups among continuous variables.

Table 2. Control variables balancing before and after matching: fathers with at least one child aged ≤ 5 years vs. childless men

	Before matching				After matching			
	Mean				Mean			
	Treated (Fathers)	Controls (Childless)	% bias	Variance Ratio	Treated (Fathers)	Controls (Childless)	% bias	Variance Ratio
Age[1]	38.090	49.014	-85.8	0.14	38.086	37.793	2.3	1.01
Education	0.302	0.196	24.5		0.298	0.295	0.6	
Household income[1]	2.683	2.315	33.1	0.75	2.682	2.652	2.7	1.06

N	*199*	*927*			*198*[2]	*927*		

CHPS 2018. % bias = standardized percentage bias

[1]The variables of age and household income were entered in squared terms to achieve better balancing.

[2]1 treated was excluded by the algorithm due to no common support

Similar to men, women also show significant differences before and after matching. Mothers of child/ren up to the age of 5 are on average 35 years old, and childless controls are almost 51 years old before matching is performed. Mothers are also more likely to have reached a higher level of education and tend to have a higher income in comparison to women without children. After performing the matching, the differences are reduced and mean values are balanced with both standardized percentage bias and variance ratios reaching acceptable values.

Table 3. Control variables balancing before and after matching: mothers with at least one child aged ≤ 5 years vs. childless women

	Before matching				After matching			
	Mean				Mean			
	Treated (mothers)	Controls (Childless)	% bias	Variance Ratio	Treated (mothers)	Controls (Childless)	% bias	Variance Ratio
Age[1]	35.012	50.752	-133.1	0.10	34.370	33.997	3.1	1.08
Education	0.341	0.167	40.8		0.328	0.326	0.6	
Household income[1]	2.504	2.162	29.9	0.83	2.578	2.550	2.5	0.96
N	*252*	*1,090*			*192*[2]	*1,090*		

CHPS 2018. % bias = standardized percentage bias

[1]The variables of age and household income were entered in squared terms to achieve better balancing.

[2]60 treated were xcluded by the algorithm due to no common support

Results on Sleep: Parents of Children Up to 5 Years of Age

The effect of parenthood on various sleep variables is explored. When comparing almost identical pairs of childless men and fathers with children up to 5 years of age (Table 4), fathers are inclined towards lower social jetlag values, on average 1.16 hours, while childless men reach 1.39 hours of sleep debt, which is significant for the 10 % level (p=0.068). Sleep duration on free days yields a difference of 30 minutes in favour of childless people, also significant on the 10 % level (p=0.067). However, there are no notable differences in sleep quality and sleep duration on workdays.

Table 4. Sleep among fathers of children up to 5 years of age

	Coefficient	Bootstrapped s.e.	Z-statistics	P-value (P>|z|)
Social jetlag				
Mean outcome treated	1.16			
Mean outcome matched controls	1.39			
ATT	-0.22	0.12	-1.83	0.068

Sleep duration on free days				
Mean outcome treated	8.01			
Mean outcome matched controls	8.31			
ATT	-0.30	0.16	-1.83	0.067
Sleep duration on workdays				
Mean outcome treated	6.97			
Mean outcome matched controls	7.18			
ATT	-0.21	0.16	-1.29	0.197
Sleep quality				
Mean outcome treated	0.15			
Mean outcome matched controls	0.12			
ATT	0.04	0.05	0.78	0.436

CHPS 2018. ATT=Average Treatment Effect on the Treated s.e.=standard error. N(treated)=198, N(controls)=927. 1 treated excluded after matching due to no common support.

The contrast between childless women and mothers of small child/ren is even more pronounced (Table 5). As for social jetlag, mothers manifest 0.82 hours while for the childless, the value reaches 1.35 hours, which is statistically significant on the 0.1% level (p=0.000). Similar to fathers, mothers also tend to have shorter sleep on free days (8.12 hours) than women without child/ren (9.45 hours), with a significance level of 10% (p=0.094). There are barely any differences between the treated and controls in sleep quality and sleep duration on workdays and sleep quality.

Table 5. Sleep among mothers of children up to 5 years of age

	Coefficient	Bootstrapped s.e.	Z-statistics	P-value (P>|z|)
Social jetlag				
Mean outcome treated	0.82			
Mean outcome matched controls	1.35			
ATT	-0.53	0.15	-3.59	0.000
Sleep duration on free days				
Mean outcome treated	8.12			
Mean outcome matched controls	8.45			
ATT	-0.33	0.20	-1.68	0.094
Sleep duration on workdays				
Mean outcome treated	7.43			
Mean outcome matched controls	7.36			
ATT	0.07	0.21	0.31	0.755
Sleep quality				
Mean outcome treated	0.26			
Mean outcome matched controls	0.23			
ATT	0.03	0.07	0.41	0.681

CHPS 2018. ATT=Average Treatment Effect on the Treated s.e.=standard error. N(treated)=192, N(controls)=1090. 60 treated excluded after matching due to no common support.

Results on Sleep: Parents of Children Between 6 and 11 Years of Age

Interestingly, the sleep variables of childless men and fathers of children/ren between 6 and 11 years of age (Table 6) differ only slightly, and none of the differences is statistically significant. The matched sample of both the treated and controls manifests around 1.2 hours of social jetlag, the length of their sleep during free days being roughly 8 hours on average and on workdays almost 7 hours, with notably poor quality of sleep.

Table 6. Sleep among fathers of children from 6 to 11 years of age

	Coefficient	Bootstrapped s.e.	Z-statistics	P-value (P>|z|)
Social jetlag				
Mean outcome treated	1.24			
Mean outcome matched controls	1.23			
ATT	0.01	0.15	0.07	0.943
Sleep duration on free days				
Mean outcome treated	8.04			
Mean outcome matched controls	8.14			
ATT	-0.10	0.19	-0.54	0.588
Sleep duration on workdays				
Mean outcome treated	6.86			
Mean outcome matched controls	6.94			
ATT	-0.08	0.17	-0.48	0.635
Sleep quality				
Mean outcome treated	0.17			
Mean outcome matched controls	0.14			
ATT	0.04	0.05	0.68	0.493

CHPS 2018. ATT=Average Treatment Effect on the Treated s.e.=standard error. N(treated)=199, N(controls)=927.

The sleep routines of childless women and mothers of children/ren in the same age group vary (Table 7). Mothers once again exhibit lower social jetlag in comparison to their peers without children on a 5% significance level (p=0.035). Even though the sleep duration on free days does not differ greatly among the treated and the controls, the difference is notable on the 10% significance level (p=0.086). Besides that, sleep duration on workdays and sleep quality are comparable.

Table 7. Sleep among mothers of children from 6 to 11 years of age

	Coefficient	Bootstrapped s.e.	Z-statistics	P-value (P>|z|)
Social jetlag				
Mean outcome treated	1.10			
Mean outcome matched controls	1.39			
ATT	-0.28	0.13	-2.11	0.035
Sleep duration on free days				
Mean outcome treated	8.25			
Mean outcome matched controls	8.58			
ATT	-0.34	0.20	-1.72	0.086

Sleep duration on workdays				
Mean outcome treated	7.10			
Mean outcome matched controls	7.27			
ATT	-0.16	0.17	-0.97	0.331
Sleep quality				
Mean outcome treated	0.24			
Mean outcome matched controls	0.18			
ATT	0.06	0.06	1.06	0.287

CHPS 2018. ATT=Average Treatment Effect on the Treated s.e.=standard error. N(treated)=189, N(controls)=1090. 98 treated excluded after matching due to no common support.

Results on Sleep: Parents of Children Between 12 and 17 Years of Age

Last but not least, the comparison of childless men and fathers of child/ren older than 11 but still before reaching adulthood (Table 8) show statistical differences on a 10% level in the amount of social jetlag (p=0.079) and sleep on free days (p=0.096), with fathers once again suffering less from sleep debt but also manifesting less sleep during the weekends. Sleep duration during the week, however, is almost 7 hours and the sleep quality tends to be poor for both groups.

Table 8. Sleep among fathers of children from 12 to 17 years of age

	Coefficient	Bootstrapped s.e.	Z-statistics	P-value (P>|z|)
Social jetlag				
Mean outcome treated	1.16			
Mean outcome matched controls	1.32			
ATT	-0.16	0.09	-1.76	0.079
Sleep duration on free days				
Mean outcome treated	8.00			
Mean outcome matched controls	8.21			
ATT	-0.21	0.12	-1.67	0.096
Sleep duration on workdays				
Mean outcome treated	6.92			
Mean outcome matched controls	6.97			
ATT	-0.06	0.11	-0.52	0.601
Sleep quality				
Mean outcome treated	0.21			
Mean outcome matched controls	0.15			
ATT	0.05	0.04	1.38	0.169

CHPS 2018. ATT=Average Treatment Effect on the Treated s.e.=standard error. N(treated)=285, N(controls)=927. 3 treated were excluded after matching due to no common support.

As for women (Table 9), motherhood has a notable effect of 1% significance on social jetlag (p=0.008), suggesting that mothers suffer from lower levels of sleep debt. However, mothers of older child/ren also get less sleep than their childless peers on a 5%

significance level (p=0.017). Sleep duration during the week and rather bad sleep quality are comparable for both women with and without child/ren.

Table 9. Sleep among mothers of children from 12 to 17 years of age

	Coefficient	Bootstrapped s.e.	Z-statistics	P-value (P>|z|)
Social jetlag				
Mean outcome treated	1.13			
Mean outcome matched controls	1.48			
ATT	-0.35	0.13	-2.64	0.008
Sleep duration on free days				
Mean outcome treated	8.09			
Mean outcome matched controls	8.53			
ATT	-0.44	0.18	-2.38	0.017
Sleep duration on workdays				
Mean outcome treated	7.15			
Mean outcome matched controls	7.24			
ATT	-0.09	0.15	-0.60	0.548
Sleep quality				
Mean outcome treated	0.22			
Mean outcome matched controls	0.16			
ATT	0.06	0.05	1.09	0.277

CHPS 2018. ATT=Average Treatment Effect on the Treated s.e.=standard error. N(treated)=342, N(controls)=1090. 18 treated excluded after matching due to no common support.

Discussion

Contributing to the theory of the Social Zeitgeber, which suggests disturbed sleep by life events such as childbirth, and to the theories of gendered responsibilities influencing sleep among parents, this manuscript explores sleep duration, social jetlag and sleep quality among childless individuals and parents.

The results do not fully support the hypothesis (H1) that parents of younger children will have the shortest sleep length. For fathers, sleep duration on both free and workdays remains relatively stable in all three age categories of their children. On free days, mothers also have a similar amount of sleep no matter the age of their children. However, on workdays, mothers of child/ren up to 5 years of age get the most sleep. This is in opposition to previous research that suggests sleep impairment for those with child/ren up to six years of age (Richter et al., 2019). When comparing childless individuals and parents, parents of the youngest child/ren and mothers of child/ren from 6 to 11 years are observed to sleep less on free days on a 10% significance level, fathers of child/ren from 12 to 17 years get less sleep, and mothers have significantly less sleep than their childless peers from the same age group even on a 5% level of significance. There are no

differences between childless people and parents on workdays in any child age group. This finding partially confirms those of Erika Hagen et al. (2013) in that parents of minor children, in general, have a shorter sleep length as opposed to those without children (Hagen et al., 2013). However, this study did not differentiate between free days and workdays. While sleep duration on free days is on average almost the same among mothers and fathers, women tend to get about half an hour more sleep on workdays, which is partially confirmed (Insana, Montgomery-Downs, et al., 2013) and partially contrasts with previous research results (Insana et al., 2014). Lower sleep duration of parents during free days is likely to be an effect of parenthood: parents may not have to go to work on free days, but they have children to take care of, which gives them a reason to get up earlier than they might have preferred.

Regarding amount of sleep and its variance between free days and workdays (H2), the results support the hypothesis: generally, sleep is about an hour longer on free days than on workdays, which also applies to the childless. The sleep duration differences are greatest for parents with the smallest children. This result is not surprising since it is quite a common practice to sleep longer on free days. Previous literature has not considered the differences between workdays and weekends.

Even though, based on previous research (Feldman, 2006; Kudrnáčová and Hamplová, 2022; Sládek et al., 2020; Yamazaki, 2007), parents were expected to suffer from lower social jetlag (H3), the results are mixed. Mothers consistently have significantly lower social jetlag when compared to their childless peers, as suggested by the previous literature. Fathers in the youngest and oldest child groups have a lower sleep debt but on a 10 % significance level, while the middle group shows no difference at all. The reason might be that since mothers are the primary caregivers, their workdays and free days are quite similar in terms of sleep routine, while fathers, as the breadwinners, are more likely to have an ordinary week, which means getting up early on workdays and little later on free days. Even though their sleep is influenced by parenthood, it does not seem to be affected to the same extent as the sleep of mothers.

Interestingly, there are no differences at all among parents in sleep quality, which is in opposition to both previous research and hypothesis (H4) and subsequently also to the assumption (H5) that there would be more pronounced differences between childless individuals and parents in the youngest age groups. Sleep quality is comparable in all groups with barely notable differences. This is possibly due to parents' sleep quality not

being particularly impaired by the presence of a child/ren: both the childless and parents rate their sleep as overall rather poor.

Limitations

There are several strengths to this article: firstly, given that sleep is influenced by the temporal organization of social life and inevitably affects the quality of life, it is a valuable contribution to the sociological debate. Yet, with rare exceptions, sleep research has been dominated by biomedical approaches. Secondly, the presented data are representative of the Czech population and the use of the PMS method helps to eliminate bias in observational studies.

The limitations include the lack of objective sleep measures (e.g., polysomnography). Nor does the study allow for longitudinal observation: there are not enough new parents in between the three CHPS waves (2018-2020) containing sleep variables to observe both within and between differences.

Conclusion

The current study explores the effect of parenthood on sleep patterns using a method of PSM. Since the previous literature indicated that the experience might differ based on gender and age of the children, these factors were considered in the models. Analysing the effect of various sleep variables (sleep duration on workdays and free days, social jetlag and sleep quality) on childless individuals and parents and taking into account the previous literature – in many cases inconsistent – some interesting findings emerge: the longest sleep phase seems to be reached among mothers of small children. Overall, childless individuals and parents have similar sleep patterns, getting less sleep during workdays and more sleep during the weekends. But parents are deprived of sleep on free days, especially when their child or children are 12 or older. This is also connected to mothers exhibiting lower social jetlag, which suggests that the child/ren are the equivalent of full-time employment. Children, however, seem to be a disadvantage to sleep duration on free days because parents and especially mothers cannot sleep as long as they might prefer. Intriguingly, no difference was found regarding sleep quality.

Sleep is often an underestimated but essential part of our lives, one which should be given more attention, especially given the fact that healthy sleep patterns are necessary for both physical and mental wellbeing and in general high quality life. The data analysed here are

cross-sectional and pre-pandemic; future studies should ideally focus on extending the investigation into sleep and how it changes at various points in time.

6. Discussion

Sleep is a popular subject, especially in the media and public (discussed in Chapter 1.3), but it is often considered from a narrow point of view and the conventional contexts of biology and physiology. One of the dissertation's aims is to address sleep as a multidisciplinary subject and challenge the existing literature and research to include a social sciences perspective. In three independent yet interconnected empirical chapters, I investigated sleep in the context of quality of life. Building on previous mainly biomedical studies, the dissertation delivers a fresh view of sleep analysis. A range of methodological approaches were applied (multilevel repeated measurement models, multilevel mixed-effects models, and propensity score matching), placing sleep into a sociological context. Sleep patterns and their links to quality of life were analysed, with a detailed study of the collision of family and work and resultant misalignment of biological and social rhythms. Inspired by the findings, the research was extended with an analysis and comparison of sleep patterns in childless individuals and parents. This concluding chapter contains several subsections and generally follows the structure of discussion in an academic article. The first subsection highlights the most important and interesting results emerging from this research. The second subsection presents an analysis of results and the contribution of the research to contemporary Czech society. The third subsection discusses the limitations of the research. The final subsection contains recommendations for future sleep research.

6.1. Summary

The research question which linked and combined the individual parts of this work probed the relationship between sleep (and its various aspects) and quality of life in the Czech population. Over time, this question evolved and adopted a more specific form with three additional, specific aims: (i) a study of the long-term effects of sleep on general well-being, (ii) sleep examined in the contexts of work and family, and (iii) further analysis of sleep in the family context and a comparison of sleep in relation to parents and childless individuals.

My dissertation research has drawn from and contributed to some of the existing theoretical frameworks. One of them is the Integrative quality-of-life theory (Ventegodt, Merrick, and Andersen 2003) with five dimensions of quality of life (life satisfaction, happiness, work satisfaction, well-being and subjective health) which were empirically

shown to be influenced by sleep and particularly by sleep quality (Chapter 3). Other theoretical bases claiming the existence of the link between sleep and the quality of life are Repair and Restoration theory suggests that only sufficient and good quality sleep can provide both physical and mental restoration and repair compared to no other physiological process (Ezenwanne 2011). Also, the Social Zeitgeber Theory included in one of the other articles (Chapter 5) suggests that major life events are disruptors of established social practices and hence also the sleep rhythms and inevitably affect the quality of life (Ehlers, Frank, and Kupfer 1988) which is a framework applicable especially to the clash of preferred sleep patterns in the context of work and family. Last but not least, gendered responsibilities are often referred to as major factors influencing sleeping arrangements in families (Burgard 2011; Ruppanner et al. 2021; Venn et al. 2008). Although sleep is still a relatively undeveloped theoretical concept in sociology, in an interdisciplinary context there is certainly much to work with and build on.

The empirical results in this dissertation confirmed that sleep is a good servant but poor master: too little or too much sleep is counter-productive to quality of life. Social jetlag relates only to work stress and life satisfaction, but as with sleep duration, it does not or varies little over time. By contrast, quality of sleep is the strongest sleep-related predictor of a happy and high-quality life, and it is frequently subject to changes over time.

The data on employed people in the Czech population also revealed that social jetlag is prevalent: only 6.5% of people have consistent sleep patterns and do not generate any social jetlag, whereas 54% generate at least one hour or more. Compared to the general population (Merikanto et al. 2017), the proportion of people with extreme social jetlag is notably smaller in the Czech working population. Interestingly, the premise that extended working hours (50+ per week) and commuting times cause greater social jetlag was not confirmed. The presence of small children in a household of full-time workers also did not significantly change the magnitude of social jetlag. Social jetlag was more significantly affected by self-employment (negative relationship). A comparison of social classes indicated more pronounced social jetlag in social classes III to VI (especially V – lower technical occupations and VI – routine occupations) than social classes I and II.

The relatively small impact of family status on social jetlag was startling and provided a focus for the third article presented in the dissertation. The study compared childless individuals and parents, but separate results were also generated for each group, providing interesting findings. Childless men and fathers showed few differences, whereas the results for women indicated greater variability, especially in social jetlag. Mothers

showed consistently lower variability in sleep routines between workdays and free days. Otherwise, the data indicated rather poor sleep quality among all.

6.2. Interpretations and implications

The previous section summarised some of the most surprising and interesting results, including some unproved assumptions. Let us examine the results in greater detail in relation to the entire discussion on sleep and quality of life. At the beginning of the dissertation, I asked how sleep related to quality of life. The subsequent research exclusively examined the Czech population because I was able to obtain high-quality, representative household panel data which also allowed inquiry into individual characteristics, attitudes and self-reported behaviours.

The first, specific research question probed the effects of sleep over time and the relationship of various sleep variables to quality of life. It built on the *integrative quality-of-life* (IQOL) theory (explained in detail in Chapter 3), which suggests that quality of life consists of five dimensions: well-being, satisfaction with life, happiness, subjective health and work stress. In this way, IQOL theory is more precise and better describes the entirety of quality of life than a single measured aspect. While the main goal was to study long-term effects (the data permitted observation of individuals over the course of three years), some insight into the in-between differences was also obtained, confirming the link between sleep duration and general health and happiness reported in previous studies (Kalak et al. 2014; Shen et al. 2018). Previous studies have shown that the longer the sleep duration, the worse the subjective health and happiness levels among individuals (Groeger, Zijlstra, and Dijk 2004; Kalak et al. 2014; Shen et al. 2018). Interestingly, no indication of change over time has been observed. This may simply be because the observation period (three years) is too short to discern significant changes which otherwise occur over a lifetime, for example, as a consequence of aging. The measurement tool is limited by collecting generalized data on sleep duration during a typical week at one point of the year. Consistent with other, extensive observations (Jean-Louis et al. 2000; Ritsner et al. 2004; Zeitlhofer 2000), sleep quality carries the most significance in assessing quality of life. In this case, sleep quality had significant effects on the studied dimensions of quality of life (except for work stress), and the positive links agreed with the conclusions of previous extensive research (Jean-Louis et al. 2000; Kim et al. 2011; Shao et al. 2010; Zeitlhofer 2000). Long-term changes also indicated positive changes, this time in all five quality-of-life dimensions. The results for social jetlag,

however, only broadly agreed with previous findings. While some literature (Jankowski 2014; Önder 2020) suggests that more pronounced social jetlag leads to a decrease in life satisfaction and higher levels of work stress, other sources dispute this claim (Chang and Jang 2019). Moreover, there is no effect over time. Finally, the finding that sleep quality is undeniably the strongest predictor of all the sleep variables was in line with other studies (Jean-Louis et al. 2000; Ness and Saksvik-Lehouillier 2018; Shao et al. 2010). The examined data also appears to marginally capture trends related to the Covid-19 pandemic, revealing an increase in sleep quality in 2020 that may have been a consequence of emergency lockdown measures. Foreign studies have also reported improved sleep quality in people at that time (Kocevska et al. 2020). The effects over time, however, remained unchanged. Although the results generally suggest stability in sleep habits and routines over time, it is important to note that three years may be too short a period to observe any significant changes. Minor nuances may be concealed by the value of the statistical error. The most important finding is that sleep quality (in the context of general Czech population) is a valid and reliable predictor of quality of life.

The study which followed was driven by the curiosity whether family or work obligations had a greater effect on social jetlag. The target population of the study, therefore, was the general working population. The study confirmed the hypothesis that professional and services classes were less likely to suffer from social jetlag than routine manual and non-manual labour classes which is also consistent with a previous study (Islam et al. 2018). This perhaps partially results from professional and service classes having steadier positions and more flexible working hours but also fixed work contracts. Routine non-manual and manual labourers have more variable working hours, are often required to work shifts (early morning or late evening), and tend to be paid by the volume of work done. Surprisingly, commuting time was not a significant factor despite the previous research showing the exact opposite (Gabud et al. 2015). An interesting observation was that individuals who worked on average between 40 and 49 hours per week exhibited greater social jetlag than those who worked on average 50 hours or more. This finding may either be a result of the selection effect or suggest that little to no misalignment exists between workdays and free days since extensive working hours requires treating every day of the week as a workday (i.e., getting up and going to bed at roughly the same time every day). While there is no literature addressing specifically social jetlag and its link to working overtime, there is evidence of a higher prevalence of sleep disorders among frequent overtime workers (Ribet and Derriennic 1999). Even though social jetlag seems

to be lower among those working more extensive working hours than those working up to 9 hours of overtime, it does not mean that it is a healthy and sustainable lifestyle. Moreover, the difference in the relationship between different levels of overtime and social jetlag might be influenced by other variables not included in the model such as job stress (Takaesu et al. 2021) or time management skills. Another interesting predictor of lower social jetlag was self-employment, especially among lower technical and routine occupations. Even though these positions tend to be less secure, this disadvantage is partly balanced by the relative freedom in working hours. Even though there are no studies dedicated to social jetlag and self-employment, there is empirical evidence mapping a similar phenomenon: the transition to the home office mode at the beginning of the Covid-19 pandemic-related lockdown. And these studies also showed a decrease in social jetlag (Brandão et al. 2021). Family characteristics also provided some interesting findings. In the case of both men and women, the presence of small children in the household indicated a greater likelihood of lower social jetlag than in households without young children. This observation agrees with previous studies (Caci et al. 2005; Feldman 2006; Sládek et al. 2020; Yamazaki 2007), and may be simply because parents tend to have more structured schedules around caring for children. Parents are also more likely to have similar schedules on both workdays and non-workdays, thus reducing the social jetlag due to family obligations.

The effect of family characteristics on sleep was one of the hypotheses of the previous study, but it was a relatively superficial exploration since it was not the main focus of the article which demanded deeper inquiry. The final study therefore investigated not only the working population but also the general Czech population, grouped according to having/not having a child and gender. The findings were fascinating: although previous research shows the opposite (Richter et al. 2019), the results of my study suggest that mothers of small children (up to 5 years of age) tend to sleep the longest, likely compensating for hormonal load and stress encountered in caring for a baby but also the housework they are traditionally expected to perform when staying at home with children. The Czech Republic has one of the longest periods for parental leave in the world: up to four years (Ministerstvo práce a sociálních věcí 2022). This period can also be prolonged with the timing of a second or even third child which is quite frequent in the context of advancing age in first-time mothers (Šťastná, Slabá, and Kocourková 2019). Men, however, do not take parental leave as frequently: parental allowance is received by between 1% and 3% of fathers every year (MPSV 2021), mainly for financial reasons

since they are more likely to be family breadwinners and because child support during parental leave does not significantly ease the family's budget (LOM 2020). It is, therefore, not surprising that having a small child does not affect the father's sleep duration nearly to the extent as the women's: sleep in both parents is significantly shorter during free days (weekends), but the mother's sleep is affected significantly more than the father's. Sleep on workdays, however, does not differ between mother and father possibly because childcare might be roughly the same time commitment as work. As highlighted in the previous study (Kudrnáčová and Hamplová 2022), this is not surprising since caring for a child is an obligation. Parents, especially mothers as the primary caregivers in the Czech Republic, are required to look after children not only on workdays but also weekends. The data indicated approximately one hour longer sleep duration on weekends, which was further confirmed by examining the level of social jetlag. While mothers tend to have a consistent sleep routine, regardless of the day of the week, fathers are more likely to accumulate social jetlag since they tend to go to bed later and get up later on free days, especially when the children are very small or before the age of 12. This finding suggests that fathers may be more likely to participate in caring for older children who are perhaps "more fun" and when mothers return to employment (LOM 2020). An investigation of parental sleep quality revealed no differences according to the age of the child. This finding is in compliance with one of the previous studies (Krämer and Rodgers 2020) but in opposition to some other studies, especially those exploring sleep quality among parents a couple of weeks postpartum either claiming a slight increase (Dørheim et al. 2009; Insana, Williams, and Montgomery-Downs 2013) or decrease in sleep quality (Gay, Lee, and Lee 2004; Richter et al. 2019). A possible explanation is generally poor sleep quality overall, or a mediation variable may not have been captured by the analysis. Life satisfaction, which tends to be slightly higher in parents because the joy of a child may compensate for any impairment to quality or quantity of sleep, may have also affected the results.

6.3. Limitations

The dissertation is an important contribution to the research on sleep and quality of life and generally to multidisciplinary research. Applying advanced statistical methods and novel perspectives on a Czech population data sample, the dissertation provides an original sociological insight into challenges which might otherwise be perceived as purely physiological or biomedical. The independent yet interlinked original studies

incorporated into this dissertation have many strengths. Chapter 3 explores sleep and quality of life both in time and cross-sectionally, comprehensively measuring a number of previously untested sleep variables in relation to quality of life. Chapter 4 offers an insight into the combination of work and family in relation to social jetlag. Chapter 5 is unique for its incorporation of a design similar to quasi-experiment (only without causal inferences) which allowed a comparison of sleep between parents and childless individuals and investigation of sleep variables not typically studied to this extent in similar analyses.

The dissertation also has some limitations. One of the more generally applicable limitations is its sole focus on a Czech population sample and lack of international comparison. A lack of relevant data, however, dictated this choice. Although international surveys such as the European Social Survey (ESS) do indeed investigate quality of life or some of its aspects with questionnaires, sleep as a subject is infrequently addressed, especially not to the extent in the research presented here.

The methodological choices were also constrained by the CHPS measurement tools. This survey relies on subjective, self-reported measurements and is unable to measure the frequency and duration of napping. These variables are potentially important indicators in parents, especially mothers since in most cases they are the care givers who remain at home on parental leave with children. Life stages might also be an indicator for napping, which has previously been shown to affect other areas of life quality. Wearable electronics would have been an ideal measurement tool to provide objective large-scale data. The reliability of the data from such devices, however, depends on the type of the wearable, brand and also on the wearer and their ability to use and wear the device correctly. And even though there are some performance validation studies available (e.g., Mehrabadi et al. 2020; de Zambotti et al. 2016), more research is still needed in order to fully assess different types of wearables for sleep tracking.

All the studies incorporated into this dissertation are purely correlational and do not allow for causal claims. However, the theoretical frameworks used in the main body of the dissertation and previous studies (Kalak et al. 2014; Shin and Kim 2018) confirm that sleep is the predictor of quality of life and not the other way around. One of the strengths of Chapter 3 is its longitudinal analysis, although it studies a relatively short period, and the results should be interpreted with caution. The limitations of Chapter 4 and Chapter 5 are cross-sectional designs.

These limitations, however, were beyond the control of the research presented here, a consequence of either the character of the available data, the selected research methods, or the complexity inherent in the research questions. The dissertation may serve though as suitable inspiration for future research.

6.4. Recommendations

The aim of all three empirical sections was to bridge certain knowledge gaps and contribute to scientific discourse on the subject of sleep and quality of life. I am confident that my research has been partially successful, but much is still unknown and yet to be uncovered. This section, therefore, discusses proposals for further research.

The range of existing international studies have usually studied smaller samples from a number of countries. The lack of comparable international studies on the relationship of sleep to quality of life is a gap which can be addressed by future work. Studies which have investigated this relationship usually explored a sample from only two or three countries. A complex, multi-national comparison is not possible because the methodologies for studying sleep and quality of life vary significantly. Avenues for future research, therefore, would include an extensive multi-national comparison, preferably initiated by one of the renowned collaboration programmes.

Chapter 2.2.2 discussed the limitations of sleep measurement tools alongside alternative methods. To briefly reiterate: the MCTQ questionnaire used consistently in this dissertation to measure various sleep variables is a valid and reliable tool which is recommended by researchers and provides a snapshot of the respondent's sleep patterns on a spectrum. While this spectrum is preferred (for having no precise divisions between morning and evening types), the actual sleep routine captured is debatable, and the kind of information it offers researchers is problematic. Undoubtedly, the MCTQ allows the collection of data on sleep duration and the misalignment between workdays and non-workdays, but the pertinent question is how to interpret the circadian preferences computed from the MCTQ. A circadian preference is generally described as an inclination or preference to sleep or be active at certain times of day (Adan et al. 2012). However, the measurement tool focuses on actual sleep routines, not the preferences, even if the computation accounts for matters such as using an alarm on the weekend. A debate between researchers on willing changes to sleep routines is ongoing. Naturally, sleep entails more than only biological preferences, which are affected, to an extent, by phenomena such as artificial light, but also social obligations. Future research should

include comprehensive studies which measure both the actual sleep routines and the sleep preferences of respondents. These data could then be compared. Some laboratory trials may already be doing this type of research, but they are usually small in scale because they are expensive to run, and to the best of my knowledge, none study preferences in comparison to actual sleep routines. This was briefly discussed in Chapter 2.2.2 but not mentioned as a limitation (Chapter 6.3) in the dissertation because the uncertainties and complexity surrounding the concept of circadian preferences prohibited inclusion in any empirical study. Yet, circadian preferences and their related social aspects are also important subjects for future sociological research.

A research setting allowing individuals to be monitored over extensive periods such as an entire year or several months would also provide fascinating and valuable insight into both sleep and quality of life. The experiment could capture sleep experiences and quality of life (or some of its dimensions) in each season, during typical work weeks or during vacations. This could potentially examine periods of life changes (e.g., pregnancy, birth of a child, extreme or stressful situations). A drawback to this type of research is a major investment of time and finances: for example, smart watches, which are expensive, for measuring sleep variables, and frequent quality of life surveys, which require long-term project commitment, for collecting and processing data. However, the knowledge gained from this research would contribute significantly to our understanding of sleep in relation to quality of life. Instead of providing the wearable electronics to a specific group of respondents, however, the data could be obtained from the companies that manufacture the wearable technology and make applications tracking sleep and collect data from their customers at the same time. Not only smart phones but also smart watches and smart rings have dramatically advanced over the past years and are rapidly growing in popularity. They have been found to be relatively accurate and have a great potential for large-scale longitudinal assessment of health and could serve as a way to improve population sleep health. Due to all these benefits, they are undoubtedly the future of sleep research.

7. Conclusion

At the beginning of my PhD research, I aimed to discover how sleep was linked to quality of life in the Czech population. This question guided me through my research and formed the backbone of my search for answers in this dissertation to more specific questions on the long-term effects of sleep on quality of life, the links between work and family obligations in the working population, and the differences between parents and childless individuals according to selected sleep aspects.

The results indicated that sufficient high-quality sleep is a precious pre-requisite for healthy life and that social jetlag relates directly to some of its aspects. Even though sleep habits such as sleep duration and schedule tend to stay unaltered over the years, sleep quality is the most likely to change since it is very susceptible to changes in other areas of our lives. Work commitments have a greater effect on misalignment between work and free days, suggesting that family obligations reduce social jetlag and other disparities during the weekly sleep schedule. Surprised by the small effect of family on sleep, I expanded on this finding by analysing sleep in parents and childless individuals, taking into account gender to decrease the selection bias. This provided some interesting results which suggested significant differences between childless women and mothers. Mothers had a particularly short sleep during weekends. Sleep for fathers was also affected, but diametrically less so than for mothers. Surprisingly, a comparison of sleep quality did not reveal any differences and indicated that the Czech population generally suffers from low quality sleep.

Unfortunately, my research was unable to overcome some drawbacks, which are clearly stated in the relevant sections, but they do not weaken the contribution of this work to the discussion on sleep and quality of life. My main critique of the existing literature is that sleep research, for the most part, separates sleep from the social context in which it occurs. I initiated this dissertation in response to the scarcity of sleep research in the Czech Republic and narrow range of views offered by studies from around the world, but it is also an appeal and invitation for other researchers to join and explore a multidisciplinary approach and demonstrate the importance of sleep (and other areas that might have been incorrectly categorised as purely physiological or biological) in other disciplines. The dissertation also highlights the importance of focusing separately on various population groups such as workers or parents, because each has different needs, lifestyles and sleep habits.

This research is only a beginning, and of course, a long path is ahead. Although sleep is increasingly appearing in public discussion, it is still the most overlooked and underrated aspect of a healthy lifestyle. Perhaps it is now the task of social scientists to initiate change to the erroneous notion of sleep as waste of time and cultivate an appreciation of its true nature and significant benefits when it is done adequately and sufficiently – sleep is an essential component in the journey towards a good life.

8. Abstrakt

Význam a hodnota kvalitního spánku pro naši pohodu jsou často podceňovány. Ačkoli je spánek částečně podmíněn geneticky, je také silně determinován environmentálními a sociálními faktory. Velká část výzkumu v této oblasti se však omezuje na studie s biomedicínským přístupem a sociologické aspekty spánku jsou zkoumány jen zřídka. Cílem disertační práce je překlenout tuto mezeru ve znalostech, pojednat o spánku v kontextu kvality života a aplikovat různé analytické metody na data získaná ze vzorku české populace, aby bylo možné studovat, jak spánek ovlivňuje a je ovlivňován kvalitou života.

Motivem disertační práce je nedostatek výzkumů longitudinálních vlivů spánku a životní pohody, a proto je její součástí výzkumný článek (kapitola 3) věnovaný dlouhodobému vlivu změn délky spánku, kvality spánku a sociálního jetlagu (nesoulad mezi biologickým a sociálním časem) na kvalitu života (spokojenost se životem, štěstí, pracovní stres, subjektivní zdraví a životní pohodu). Druhý článek zkoumá sociální jetlag a jeho souvislosti s prací a rodinou (kapitola 4). Třetí článek zkoumá spánek v kontextu typů rodin a vliv rodičovství na délku spánku a sociální jetlag a také porovnává kvalitu spánku u bezdětných jedinců s rodiči s dětmi různého věku (kapitola 5).

Výsledky mého akademických zkoumání naznačují, že kvalita spánku je nejdůležitější proměnnou spánku ze všech a že délka spánku i sociální jetlag mají tendenci zůstávat v průběhu času relativně stabilní. Zdá se také, že sociální jetlag je těsněji spojen spíše s pracovním prostředím než s rodinou: osoby samostatně výdělečně činné a profesní třídy trpí sociálním jetlagem méně často, zatímco nižší profesní třídy mají vyšší míru sociálního jetlagu, což naznačuje značný nesoulad mezi pracovními a volnými dny. V návaznosti na studii o typech rodin ukazuje srovnání bezdětných osob a rodičů, že tyto dvě skupiny mají podobný spánkový režim a zažívají stejně špatnou kvalitu spánku. Rozdíly mezi pohlavími však ukazují, že matky mají nedostatek spánku zejména ve volných dnech a že péče o děti se rovná práci sedm dní v týdnu namísto průměrných pěti dní v týdnu.

9. References

Chapter 1 and 2

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Chapter 3

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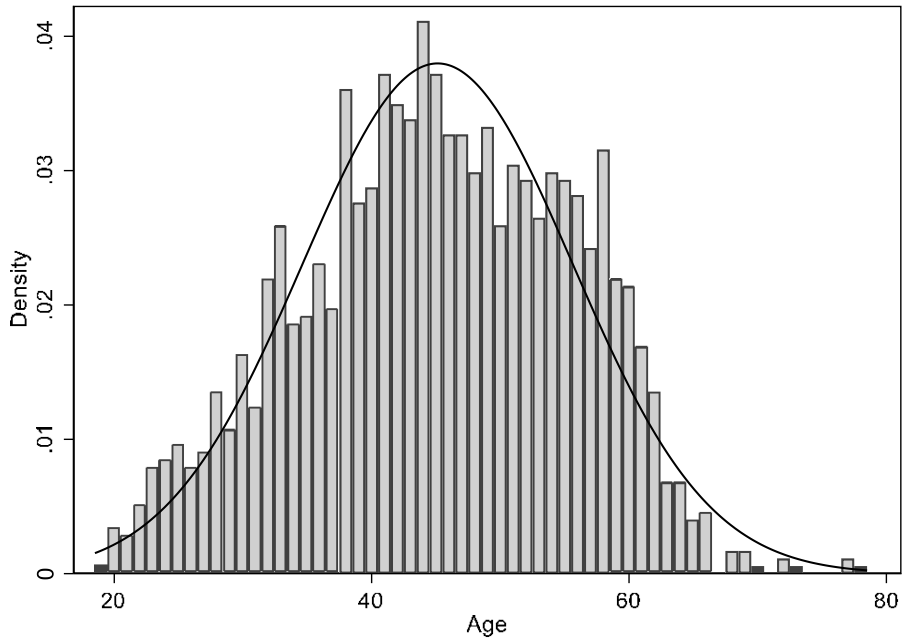
10. Appendices

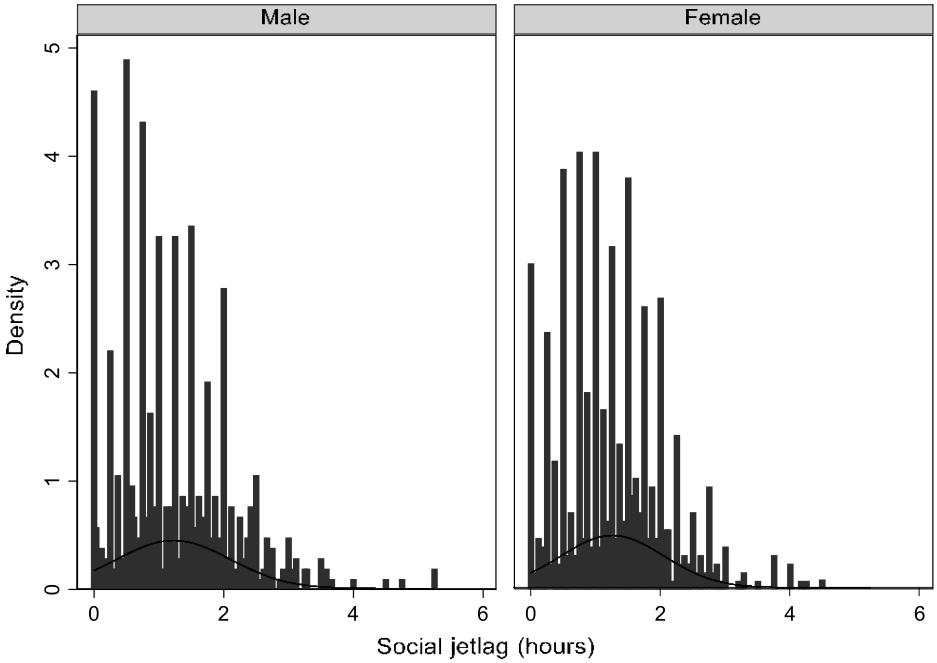
Chapter 4

Figure A1. Age distribution of the analytical sample

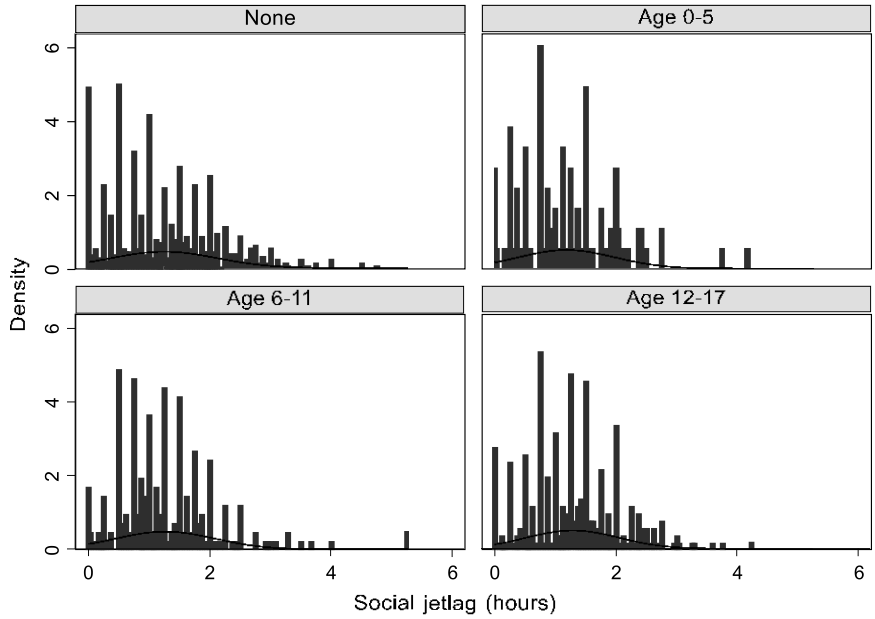


Note: N = 1760, weighted
Source: Czech Household Panel Study 2018

Figure A2. Age by social jetlag distribution of the analytical sample



Note: N = 1379, weighted
Source: Czech Household Panel Study 2018
Figure A3. Households with children age group distribution of the analytical sample



Age 0-5 = at least one child between the age of 0 to 5
Age 6-11 = at least one child between the age of 6 to 11
Age 12-17 = at least one child between the age of 12 to 17
Note: N = 1760, weighted
Source: Czech Household Panel Study 2018

Table A4. Estimated Coefficients From Mixed-Effects Regression With the Dependent Variable: Social Jetlag, controlling for Best Alertness midpoint (BAmid)

	M1	M2	M3	M4
Age	-0.012**	-0.012**	-0.011**	-0.011**
Sex (*male)*				
Female	0.042	0.083	0.079	0.077
Best Alertness midpoint	0.009	0.01	0.01	0.01
Average working hours per week *(< 40 hours)*				
40 hours		0.121*	0.123*	0.125*
41-49 hours		0.181**	0.181**	0.189**
50 hours or more		0.051	0.046	0.046
Self-employed				
Yes		-0.398**	-0.403**	-0.215*
Commuting time		0.002*	0.002*	0.002*
Munincipality size	-0.007	0.005	0.004	0.003
Social class *(I - managers, higher grade professionals, employers etc.)*				
II - Lower-grade professionals etc.		0.094		
III - Intermediate occupations		0.160*		
IV - Lower services, sales, clerical		0.161*		
V - Lower technical occupations		0.494**		
VI - Routine occupations		0.438**		
Social class *(I & II)*				
Class III & IV			0.113*	0.147**
Class V & VI			0.416**	0.485**
Social class#Self-employed				
Class III & IV#Self-employed				-0.276
Class V & VI#Self-employed				-0.507**
Constant	1.667**	1.282**	1.335**	1.300**
Bayesian information criterion	3497.10	3451.28	3432.40	3435.58

* p<0.05, ** p<0.01
Note: N = 1435
Source: Czech Household Panel Study 2018

Table A5. Estimated Coefficients From Mixed-Effects Regression With the Dependent Variable: Social Jetlag among Professional and Service Classes, controlling for Best Alertness midpoint (BAmid)

	M1	M2	M3	M4	M5
Age	-0.014**	-0.013**	-0.013**	-0.013**	-0.014**
Sex (*male)*					
Female	0.026	0.064	0.066	0.049	-0.116
Best Alertness midpoint	0.006	0.008	0.008	0.008	0.007
Partner/Spouse at home	-0.118*	-0.076	-0.075	-0.075	-0.07
At least 1 child of age 0-5	-0.144*	-0.142*			
At least 1 child of age 6-11	-0.028	-0.042	-0.041	-0.042	-0.038
At least 1 child of age 12-17	0.058	0.045	0.039	0.045	0.041
Average working hours per week *(< 40 hours)*					
40 hours		0.104	0.095	0.109	-0.037
41-49 hours		0.156*	0.104	0.161*	0.003
50 hours or more		0.028	0.031	0.033	-0.119
Self-employed					
Yes		-0.407**	-0.408**	-0.406**	-0.410**
Commuting time		0.002*	0.002*	0.002*	0.002*
Social class *(I & II)*					
Class III & IV		0.102*	0.099*	0.101*	0.095*
Class V & VI		0.407**	0.409**	0.405**	0.405**
At least 1 child of age 0-5			-0.208	-0.182*	-0.241
At least 1 child of age 0-5#Working hours per week (< 40 hours)					
child#40 hours			0.017		-0.034
child#41-49 hours			0.313		0.207
child#50 hours or more			-0.036		0.062
At least 1 child of age 0-5#Female				0.081	0.056
Female#Working hours per week (< 40 hours)					
Female#40 hours					0.199
Female#41-49 hours					0.143
Female#50 hours or more					0.244
Female#At least 1 child 0-5 of age#Working hours per week (< 40 hours)					
Female#child#40 hours					0.112
Female#child #41-49 hours					0.32
Female#child #50 hours or more					-0.277
Constant	1.864**	1.572**	1.600**	1.578**	1.741**
Bayesian information criterion	3502.92	3441.538	3457.635	3448.187	3501.188

* p<0.05, ** p<0.01

Note: N = 1435

Source: Czech Household Panel Study 2018

Chapter 5

Table A1. Control variables balancing before and after matching: fathers with at least one child aged ≥ 6 and ≤ 11 years vs. childless men

	Before matching				After matching			
	Mean				Mean			
	Treated (Fathers)	Controls (Childless)	% bias	Variance Ratio	Treated (Fathers)	Controls (Childless)	% bias	Variance Ratio
Age[1]	41.834	49.014	-56.9	0.12	41.834	42.322	-3.9	0.95
Education	0.281	0.196	20.0		0.281	0.296	-3.5	
Household income[1]	2.809	2.315	44.2	0.77	2.809	2.749	5.4	1.24
N	*199*	*927*			*199*	*927*		

CHPS 2018. % bias = standardized percentage bias
[1]The variables age and household income were entered in squared terms to reach a better balancing.

Table A2. Control variables balancing before and after matching: mothers with at least one child aged ≥ 6 and ≤ 11 years vs. childless women

	Before matching				After matching			
	Mean				Mean			
	Treated (Mothers)	Controls (Childless)	% bias	Variance Ratio	Treated (mothers)	Controls (Childless)	% bias	Variance Ratio
Age[1]	39.209	50.752	-97.1	0.11	39.376	39.423	-0.4	1.0
Education	0.286	0.167	28.6		0.243	0.228	3.8	
Household income[1]	2.610	2.162	39.0	0.84	2.566	2.550	1.4	1.0
N	*287*	*1,090*			*189*[2]	*1,090*		

CHPS 2018. % bias = standardized percentage bias
[1]The variables age and household income were entered in squared terms to reach a better balancing.
[2]98 treated were excluded by the algorithm due to no common support

Table A3. Control variables balancing before and after matching: fathers with at least one child aged ≥ 12 and ≤ 17 years childless men

	Before matching				After matching			
	Mean				Mean			
	Treated (Fathers)	Controls (Childless)	% bias	Variance Ratio	Treated (Fathers)	Controls (Childless)	% bias	Variance Ratio
Age[1]	42.656	49.014	-49.7	0.15	42.653	42.970	-2.5	0.95
Education	0.278	0.196	19.2		0.270	0.284	-3.4	
Household income[1]	2.847	2.315	47.6	0.77	2.846	2.891	-4.0	1.02
N	*288*	*927*			*285*[2]	*927*		

CHPS 2018. % bias = standardized percentage bias
[1]The variables age and household income were entered in squared terms to reach a better balancing.
[2] 3 treated were excluded by the algorithm due to no common support

Table A4. Control variables balancing before and after matching: mothers with at least one child aged≥ 12 and ≤ 17 years vs. childless women

	Before matching				After matching			
	Mean				Mean			
	Treated (Mothers)	Controls (Childless)	% bias	Variance Ratio	Treated (Mothers)	Controls (Childless)	% bias	Variance Ratio
Age[1]	41.081	50.752	-80.4	0.13	41.102	41.056	0.4	0.98
Education	0.328	0.167	37.9		0.292	0.278	3.4	
Household income[1]	2.725	2.162	49.4	0.82	2.725	2.725	0.0	1.03
N	*360*	*1,090*			*342*[2]	*1,090*		

CHPS 2018. % bias = standardized percentage bias

[1]The variables age and household income were entered in squared terms to reach a better balancing.

[2]18 treated were excluded by the algorithm due to no common support