

Do Rich People Sleep in Peace?

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Abstract

Background: Sleep is undoubtedly an inevitable part of our life. Despite an abundance of literature on sleep and its determinants and influencing factors, little has been explored on independent association of income with sleep. This study examines the relation of income with sleep quality and whether health plays a role in explaining the socioeconomic differences in sleep.

Methods: Data from the Canadian Community Health Survey was used for the study including several sociodemographic, socioeconomic, lifestyle, and self-reported health variables. Logistic regression analyses were used to examine if the association between income and trouble sleeping was independent of other factors as well as whether health status mediates the socio economic effects on sleep.

Results: Income was significantly associated with sleep quality both independently and after adjusting for all other variables. In unadjusted models, relatively higher income groups were less likely to have trouble sleeping than the lowest income group. However, in the adjusted model, the odds of trouble sleeping was higher and significant for the highest income group (OR=1.14; $P < 0.01$). Additionally, health status fully mediated the effect of income discrepancies in sleep but only for lower income groups. Higher education level was associated with higher odds of sleep difficulty (OR=1.2; $P < 0.01$).

Conclusion: Being socioeconomically disadvantaged might contribute to poor sleep quality, but higher income also does not protect against sleep problems. Lower income groups are vulnerable to poor health status that can explain their sleep quality while further research is needed to address the sleep problems among the higher income group.

Do Rich People Sleep in Peace

Sleep is considered to be one of the major determinants of health. According to the National Sleep Foundation, 7-9 hours of sleep is ideal for adults per night (Hirshkowitz et al., 2015). A report by the Centers for Disease Control and Prevention after analyzing data from the National Health and Nutrition Examination Survey (NHANES) for the duration of 2005 to 2008 showed that around one-third of U.S residents lacked adequate sleep (Centers for Disease Control and Prevention, 2011). Inadequate sleep not only disrupts performing daily activities like concentrating on works, memorizing, driving, managing financial affairs but also poses the risk of several physical morbidities including cardiovascular, metabolic, endocrine dysfunction as well as mental health problems like depression or mood disorders when the sleep deprivation is chronic (Medic et al., 2017). Apart from the individual sufferings, sleep deprivation is also posited to cause sleepiness or fatigue-related accidents, evident by past histories of catastrophes that were attributed to human errors from sleepiness (Dinges, 1995). Pertaining to the seriousness of sleep-related problems, it is now considered a public health concern (Watson et al., 2015). The increasing prevalence of sleep-related problems over the last decades has drawn the attention of researchers and in the past, several studies have established the relation between abnormal sleep behavior and mortality (Kripke et al., 1979; Heslop et al., 2002).

However, the number of studies investigating the effects of sleep on different health issues are far more than the count of studies that looked at the determinants of sleep disparity. There are several socio-economic, cultural, demographic, and health-related factors that influence sleep duration and quality (Knutson, 2013). Although initial sleep research was more grounded in its relation to health conditions, a growing number of studies are now examining other influencing factors of sleep. Several studies have shown a strong association between

socioeconomic conditions with sleep quantity and quality (Patel et al., 2006). Lower socioeconomic status (SES) has been an important indicator of poor health outcomes and chronic conditions and part of this association has been explained through the mediating role of sleep indicating higher-income improves sleep quality which in turn has a positive impact on physical and mental health (Moore et al., 2002). Whereas most of the studies showed that poverty and lower SES contribute to sleep deprivation, there are others who either supported the antithetical doctrine that higher wages lead to less sleep (Adam, 2006) or failed to show any direct relation between sleep quality and a socioeconomic status indicating other modifiers for this relation including age, gender, and ethnicity (Knutson, 2013; Patel et al., 2010). The socioeconomic position is usually measured with income, education, housing condition, and occupation, or employment status, however, income is considered to be the single best indicator of living standards and has a direct impact on health (Galobardes et al., 2006). Another study supported the higher relevance of income to sleep and health outcomes than education or occupation advocating the notion that higher education has only an indirect impact on sleep by providing scope for better job opportunities, which in turn increases income, in other words, the relationship between education and sleep quality is mediated by income (Moore et al., 2002).

Despite the abundance of literature on socioeconomic determinants of sleep, studies looking into the direct relationship between income and sleep are sparse. Beyond this, further research is required for a deeper understanding of the association of sleep quality with socioeconomic status while accounting for other sociodemographic and health behavior factors. Additionally, it remains unclear how health status both physical and mental influence of this SES-sleep relation. Therefore, the purpose of the study is to examine the relationship between household income and sleep quality as well as explore the role of health status in sleep disparity.

The rest of the study is presented as follows: First, we will review the previous literature that explored the characteristics of sleep and its effects on health, its association with other physical and non-physical factors, especially with socioeconomic factors, and point out what is already known and what is still required to be studied. Then, we will describe our purpose of this study and what we are going to investigate. After that, we will give an insight into our data, sample size and sample characteristics, sampling strategy, data collection procedures, and elaborate on the type of data we will analyze. In the result section we will analyze the data with descriptive statistics to see the population characteristics and logistic regression analysis to examine the nature, direction, and strength of the association between an individual's income and sleep quality after controlling for other confounding variables. Then, we will discuss and compare the results to see any inclination or deviation of the findings from previous similar studies. After the results are discussed thoroughly, we will highlight the limitations of our study and measures to improve those in the next studies along with the academic and practical implications of our research findings. We believe that our study will be able to give better insight into the research domain of sleep as well as provide the scope for future research in this context.

Literature Review

Sleep Measures

Researches on sleep disparity have focused on two main measures of sleep in terms of sleep quantity and quality. Whereas sleep quantity is easily measured by the number of hours sleeping, sleep quality is more of a subjective measure which is described often as the feeling of how well the person slept without having trouble falling asleep, staying asleep, staying awake, or general satisfaction with sleep (Pilcher et al., 1997). While the sleep pattern and its relation with other determining factors or consequences have mostly been studied for the sleep duration, a

growing number of studies are emphasizing the importance of sleep quality to explain the disparity (Patel et al., 2010). Pilcher et al. (1997) after examining the relationship between sleep quantity and quality with measures of general well-being, health, and sleepiness concluded that sleep quality is more related to the physical, mental well-being among the non-clinical population who slept for an average of 7-8 hours. Moore et al. (2002) also provided evidence for a strong relation of sleep quality with SES factors and health variables in a relatively larger sample where sleep quantity had insignificant relation with SES measures.

Adverse Effects of Sleep Disturbances

Reduced sleep duration and quality, both lead to negative impacts on physical and mental well-being. A study has shown that chronic sleep loss acts as a risk factor for insulin resistance and Type 2 diabetes by impairing glucose metabolism (Spiegel et al., 2005). Excessive weight gain and obesity among young adults are also linked to sleep debt, which is explained by the dysregulation of leptin and ghrelin levels that control hunger and appetite (Spiegel et al., 2004). There is also notable evidence that sleep disturbances are highly associated with hypertension (Vgontzas et al., 2009) and other cardiovascular risks (Sabanayagam et al., 2010). Even the risk of several different types of cancer like breast cancer, oral cancer, and prostate cancer is highly associated with a lack of sleep and related disorders (Fang et al., 2015; Sigurdardottir et al., 2013). Apart from the physical consequences, chronic sleep deprivation also precipitates psychosocial issues ranging from emotional stress to anxiety and depression (Medic et al., 2017; Tkachenko et al., 2014).

Factors Influencing Sleep

Although research is ongoing to identify the factors that significantly influence the sleeping pattern and behavior among the population, previous studies have succeeded to

recognize some important determinants of sleep. It is already established that sleep-related problems are attributed to a number of factors related to socio-economic, lifestyle, environmental, psychosocial, and health conditions (Colten & Altevogt, 2006).

Socio-demographic Factors

Amongst the demographic factors, age, gender, marital status, race are mentioned repetitively that influence sleep. A large-scale meta-analysis consisting of articles published between 1960 to 2003, including 3,577 participants of 5 to 102 years old showed that total sleep time, sleep efficiency, and REM sleep decreased significantly with advancement of age (Ohayon et al., 2004). Incidence of self-reported sleep complaints is more prominent among women, which are partly due to hormonal influence specifically during the menopausal transition (Howard et al., 2008). Ethnicity has been regarded as another major factor that is responsible for sleep inequality across different ethnic groups, especially between whites and non-whites (African- or Asian-Americans, Latino) (Fox et al., 2018; Goodin et al., 2010). While there is controversy over the association of marital status and sleep quality, still study shows that both sleep duration and quality were better among people who had a spouse or partner (Chen et al., 2015).

Psychosocial Factors

The relation between sleep and psychosocial conditions like mood disorders (bipolar, depression), anxiety disorders are usually bi-directional as these conditions can lead to reduced sleep quality which again exacerbates the conditions (Knutson, 2013). A cross-sectional survey of 2,762 Korean adults showed that after controlling for other confounding variables, participants with insomnia were 10 times more likely to have anxiety and around 20 times more likely to have depression than those without insomnia (Oh et al., 2019).

Health Indicators of Sleep

Analogous to the psychosocial factors, the association between sleep and other morbidities is reciprocal. For example, inadequate sleep precipitates an uncontrolled appetite, which is associated with weight gain and obesity (Watanabe et al., 2010). Conversely, obesity can lead to sleep disorders like obstructive sleep apnoea (Crummy et al., 2008). Likewise, chronic sleep loss is thought to induce insulin resistance and type 2 diabetes, however, sleep disturbances owing to the discomfort, nocturnal cramps, or paresthesia in diabetes are not uncommon (Sridhar & Madhu, 1994). Arthritis is another common chronic condition among adults that are highly associated with sleep-related problems, which is partly explained by the pain associated with the condition (Louie et al., 2011). Among other significant comorbidities that have been mentioned repetitively in the studies in relation to sleep are hypertension, heart disease (Michal et al., 2014), cancer (Davidson et al., 2002).

Lifestyle

Past studies have suggested that personal habits and activities greatly influence sleeping behavior and pattern. Smoking, alcohol consumption has negative impacts on sleep quantity and quality (Stein & Friedmann, 2006; McNamara et al., 2014). A study analyzing data from the World Health Survey for 38 low and middle-income countries showed that low physical activity was highly associated with sleep-related problems (Vancampfort et al., 2018).

Socioeconomic Factors

Although sleep researches started early, studies outlining socioeconomic determinants of sleep by research are relatively recent. Most of the studies examined the relationship between sleep and SES with regard to income, education level, and occupation and proposed that low

socioeconomic condition is strongly associated with subjective sleep problems and short or long sleeping durations (Grandner et al., 2010; Nomura et al., 2010).

However, previous studies that examined the association of sleep with SES and health outcomes revealed inconsistent findings. Most of the studies showed a positive association between reduced sleep duration and/ quality and lower SES. For example, the study by Mezick et al. (2008) showed that lower SES was associated with sleep latency and poor sleep quality among African American participants. Another study that examined the relationship between subjective sleep quality with perceived social status across different ethnic groups concluded that among Asian and African Americans, lower perceived social status was related to poor sleep quality, though this was not true for the Caucasian American participants (Goodin et al., 2010). However, there are other studies that concluded on different notes. Moore et al. (2002) failed to show any association between sleep duration and SES in terms of education and family income, although the sleep quantity and subjective physical and mental health status were related. A more recent study by Patel et al (2010) found a significant association between the poor sleep quality and poverty and ethnicity, where poor sleep quality persisted even among non-poor African Americans and after controlling other factors (education, employment, and health indicators) the association between only income and sleep quality was significant for poor whites, but not for poor African Americans. Adam (2006) after analyzing data from the National Statistics Omnibus Survey for 3000 households to examine the impact of socioeconomic positions on sleep quantity among 1473 respondents, however, not only found insignificant evidence of sleep deprivation among the low socioeconomic class, also suggested the opposite concept that the more wage leads to less sleep (Biddle & Hamermesh, 1990) might be true. Hence, the association between income and sleep still remains questionable.

Another point to consider is the role of health-related factors in the relationship between socioeconomic conditions and sleep. Studies showed how sleep affects health status, morbidity, and mortality (Medic et al, 2017; Arber et al., 2009; Cappuccio et al., 2010); association of sleep with other factors like sociodemographics, socioeconomics, gender, race, and ethnicity while controlling for health variables (Patel et al., 2010; Whinnery et al., 2014). Although many of them reported how the examining relations were attenuated by health-related factors the role of the health was not very clear (Stamatakis et al., 2007). Particularly, the relation between SES, health, and sleep requires further clarification (Arber et al., 2009).

Although there have been a notable number of studies on sleep-SES, still further exploration on this matter is required. We have identified several drawbacks in the current literature. First, the findings from the current literature are inconclusive in most cases rendering the scope for further exploration of the association between income and sleep (Adam, 2006; Patel et al., 2010). Second, the role of health status in the socioeconomic difference in sleep quality remains ambiguous (Arber et al., 2009); Finally, most of the studies are limited by geographical locations and small sample sizes, which limits the scope to generalize the findings to the context of the Canadian population (Stamatakis et al., 2007; Moore et al., 2002). Given the existing gap, our study is intended to explore the following research questions-

1. Is higher income associated with lower sleep disturbance?
2. Could the socio-economic disparity of sleep be explained by the perceived and self-reported health status?

Methods and Data

The study is based on data from a national level cross-sectional survey, which is appropriate to reach out to a large number of participants as this type of studies are meant to

represent the actual population so that the research findings can be implicated for the whole population for policymakers to make any decision about possible interventions or strategies to improve the quality of life of the citizens.

Data Source

For this study, we collected a subset of data from the Canadian Community Health Survey (CCHS) for the period of 2017-2018. CCHS is a cross-sectional survey that is conducted every two years in ten provinces of Canada excluding reserves and other Aboriginal settlements, Canadian Forces, institutionalized population, young aged 12-17 living in foster homes, Quebec health regions of Nunavik and Terres-Cries-de-la-Baie-James, which cumulatively consists of less than 3% of the target population. The survey collects responses from the participants (12 years of age and above) on various aspects of their social and health-related status, health care resource utilization, and other health determinants (Statistics Canada, 2018).

To ensure proper representation of the population, a stratified multi-stage sample allocation strategy is used where each age group sample is first allocated between provinces and then to health regions using power allocation of 0.75 and 0.35 respectively according to the size of their actual population. For the time period of 2017 to 2018, 94,588 individuals were surveyed and 55,600 responses were collected indicating a response rate of 58.8%.

Data were collected by the Health Statistics Division (HSD) of Statistics Canada. 25 % of the data were collected through personal interviews whereas 75% of the data were collected by telephone interviews.

Dependent Variable

Sleep Quality

For measuring subjective sleep quality respondents were asked three questions regarding the frequency of trouble sleeping, frequency of refreshing sleep, and frequency of difficulty in staying awake. Amongst these, we have taken the most relevant measure for our study - “How often do you have trouble going to sleep or staying asleep?” The responses were recorded as i) Never ii) Rarely iii) Sometimes iv) Most of the time v) All of the time and coded from 1 to 5 respectively.

Explanatory Variables

Household Income

Income was estimated as personal income from all sources, categorized in six groups and coded as - 1) No income or less than \$20,000 2) \$20,000 to \$39,000, 3) \$40,000 to \$59,000, 4) \$60,000 to \$79,000, 5) \$80,000 or more.

Covariates

Sociodemographic Factors

Among sociodemographic variables, for our analysis, we included age, sex, race, marital status, and educational attainment. As we will observe the association between income and sleep quality, we took a subset of adults (18 years and above) only with an interval of 5 years up to 80 years and above. Sex was categorized as “Male” and “Female”. Marital status was determined with four choices- “Married”, “Common-law”, “Widowed/divorced/separated”, “Single”. The number of children under 12 was included as “1=One or more persons under 12 in the household” and “0=No person under 12 in the household”. The race is included as “White” and

“Non-white” and immigration status is categorized as “Landed immigrant” and “Non-immigrant”.

Other Socioeconomic Factors

In terms of educational attainment, responses were collected for three levels- “Less than secondary school graduation”, “Secondary school graduation, no post-secondary education”, “Post-secondary certificate diploma, or univ degree”. Household size represents the number of persons in the household where 1 means a single person and 5 means five or more persons in the household. Household ownership was categorized as “Owned” and “Rented”.

Lifestyle Factor

For current smoking habits, the survey asked the respondents “At the present time, do you smoke cigarettes every day, occasionally or not at all?” We will group the variable as “Smoker” and “Non-smoker”. Alcohol consumption is included as the type of drinker (1= “Regular drinker, 2= “Occasional drinker”, 3 = “Did not drink in the last 12 months”. Physical activity was recorded in three groups according to Canada’s Physical Activity Guidelines where physically active is defined by having at least 150 minutes of moderate- to vigorous-intensity aerobic physical activity per week, in bouts of 10 minutes or more- “Physically active at/above the recommended level from CPAG”, “Physically active below the recommended level from CPAG”, “No physical activity minutes reported”.

Health-related and Psychosocial Factors

Perceived general health and perceived mental health has been coded as “Excellent”, “Very Good”, “Good”, “Fair”, “Poor”. Other chronic diseases- arthritis, high blood pressure, heart disease, diabetes, cancer are categorized as “Yes” or “No” depending on the presence or

absence of the disease. Anxiety disorders and mood disorders reported as broad categories are also coded as “Yes” or “No” for their presence or absence.

Statistical Analysis

Among the 113290 responses, 55275 (48.79%) answered the question for trouble sleeping. After removing incomplete responses and missing values for all dependent and independent variables total observations used for the analysis were 41144. Statistical analysis was done using R in RStudio. At first, descriptive analysis was completed to show the sample characteristics and distribution of each explanatory variable with regards to different categories of trouble sleeping (Table 1, Appendix). All the explanatory variables demonstrated significant associations with sleep quality using chi-square (χ^2) analyses ($P < 0.05$) as shown in Table 1. Then, several ordinal logit regression analyses were done to examine the SES impact on sleep and the mediating effect of health in the SES-sleep relationship. For a better understanding of the relationships of the explanatory variables with trouble sleeping, findings are presented and interpreted as odds ratio (OR).

Results

Descriptive Analysis

Prevalence of Sleep Disturbance by Socio-demographics

Among the respondents around 47% were male and 53% were female adults between the age group of 18- 80 and above. Around 40% were married, 15% were in common-law, 21% were widowed/divorced/separated, and 24% were single. Around 49.2% of respondents reported having trouble sleeping sometimes/most of the time/all of the time. 56% of women and 41.94% of men reported some form of sleep disturbance. Trouble going to sleep increased over the age until a certain age, highest reported by the age group of 50-54 where around 56% reported

trouble sleeping and then the proportion gradually decreased until the last age group of 80 and older. For both men and women, a similar pattern of increased sleep disturbance was observed between 55 to 69 years of age, after which it decreased in both groups although remained slightly higher among the women. According to marital status, the percentage of lower sleep quality is higher among widowed/divorced/separated (~52%) and single (~50%) than married (~48%) and common-law partners (~47%). Among the immigrants, 47% reported trouble sleeping compared to ~50% of non-immigrant Canadians who reported sleep disturbance. Comparing racial and cultural background, 49.6% of whites and 46% of non-whites had sleep problems.

Trouble Sleeping by Socio-economics

The lower two household income groups reported more sleep problems than other groups (52% of No income or less than \$20,000 group; 50% of \$20,000 to \$39,999 group). 10.76% of the lowest income group reported the most frequent trouble sleeping compared to only 5.14% of the highest income group. Interestingly, those who had completed secondary school graduation and/or had a post-secondary or university degree had more trouble sleeping (~50%) than those who did not. Among those who owned a house, 48.78% had trouble sleeping, and 50.23% of those who lived in rented houses. With an increase in the number of persons in the household, the reported percentage of poor sleep decreased, 51.33% being the percentage of poor sleep for a single-person household, 49.42% for two persons; 48.74% for three persons, 45.01% for four persons and, 45.15% for five or more persons in the household.

Trouble Sleeping by Lifestyle

Those who smoke have more prevalence of having trouble sleeping (>50%) than those who do not smoke (~47%). Similar findings were seen for those who drink alcohol regularly (~50%) and who do not drink (~46%). Unexpectedly, physically active people were more prone

to report trouble sleeping (~50%) than physically not active respondents (47%). Those who had abnormal body mass index (BMI) reported more sleep disturbance (52% of both obese & underweight) than otherwise.

Trouble Sleeping by Health Status

Around 73% of those who self-reported poor general health also reported all-time trouble sleeping and the percentage was a bit higher among those who self-reported poor mental health (~77%). Overall those who had chronic disease conditions reported more trouble sleeping than their counterparts, for example, 53.4% of people with heart disease, 53% of hypertensive respondents, 58% of asthmatic, 51% of diabetic and, 58% of people having arthritis reported significant sleep disturbance. Just over 69% of people with either mood disorder or anxiety disorder had trouble sleeping.

Econometric models

Series of ordinal logistic regression models were run to see the impact of each variable on sleep separately. Then another series of models were run where after adjusting for sociodemographic and socioeconomic variables independent association of income and sleep disturbance was shown. Then the model was further adjusted for lifestyle variables followed by health-related variables in an ordered way to show the effect of socio-economic status on sleep as well as mediating effects of health status on the SES-sleep model. The prior judgment of the primary causal ordering of the variables from previous literature influenced the order of variables entered into the models (Arber et al., 2009). Lifestyle variables were entered into the model after adjusting for socioeconomic factors with the suggestion that low socio-economic conditions lead to adopting poor health behaviors (Pampel et al., 2010) and possibly has mediating effects on the SES-health relationship (Wang & Geng, 2019). After that, variables reporting different chronic

physical conditions and perception of general health were entered into the model taking into account the preliminary judgment that poor lifestyle leads to poor health conditions. Finally, mental health conditions along with perceived mental status were included in the final model with all the variables to see whether mental health affects the relation between income and sleep more than the physical health conditions.

Unadjusted Odds Ratio

In Table 2, the unadjusted odds ratio of trouble sleeping for all groups of variables are shown. All the variables had significant impacts on sleep. Odds of females having trouble sleeping against not having trouble sleeping were 1.7 times higher than males in the unadjusted model. Those who were widowed/divorced/separated and single had respectively 1.2 and 1.13 times higher odds of having trouble sleeping than married groups. Age groups between 45 to 64 years with five years intervals had higher odds (1.2 ~ 1.4 times) of trouble sleeping than the 18-19 years old compared to those 80 years or above who had 13% lower odds of sleep problems though it was barely significant. Odds of trouble sleeping against no trouble sleeping declined by 15.6% among those who had kids under 12 than those who did not have any under 12 children at home. Non-immigrant Canadians showed higher odds (1.3 times) of trouble sleeping whereas non-whites had 23% lower odds for trouble sleeping.

For the income group of \$20,000 to \$39,999, odds of having trouble sleeping is 12% lower than the lowest income group, whereas for the \$40,000 to \$59,999 income group, odds of trouble sleeping is 15% lower and for \$60,000 to \$79,999 income group odds is 19% lower than the no income or less than \$20,000 income group. For \$80,000 or more, the odds of trouble sleeping is 16% lower than the lowest income group. Odds of trouble sleeping is 1.13 times higher among those who completed secondary school graduation but no post-secondary

education than those who did not complete Secondary school graduation. For those who had a post-secondary certificate, diploma or university degree, trouble sleeping odds are 7% higher than those who had less than secondary school graduation. Odds of trouble sleeping is 5% higher among those who live in rented houses than those who owned houses. In comparison to a single person household, a household with two persons shows 8%, with three persons shows 9%, with four persons show 21%, and with five persons shows 24% lower odds of trouble sleeping.

Odds of trouble sleeping are 16% lower among non-smokers than regular smokers whereas 13% lower among those who do not drink alcohol than regular drinkers. Odds of trouble sleeping is 6% higher among those who are physically active below the recommended level of CPAG than those who meet the recommended level. Also, odds are 9% lower among those who are not physically active. According to weight groups, the odds of trouble sleeping is 16% and 21% lower for normal weight and overweight people than those who are underweight.

Odds of trouble sleeping significantly increase with a decrease in perceived general health. For those perceiving health as “Very good”, the odds is 1.5%, for “Good”- 2%, for “Fair”- 3.3%, for “Poor” general health odds is 7.2% higher than those who perceive “Excellent” general health. A similar pattern is seen for odds of trouble sleeping for perceived mental health. For those perceiving mental health as “Very good”, “Good”, “Fair”, “Poor”, the odds are 1.5%, 2.3%, 4.6%, and 10% higher respectively than those who perceive “Excellent” mental health. Amongst the chronic conditions, odds of trouble sleeping is 36% lower among those who do not have asthma; 18% lower among those who do not have heart disease; 16% lower among those who do not have high blood pressure; 9% lower among those who do not have diabetes, and, 40% lower among those who do not have arthritis compared to their counterparts for each disease condition. The highest difference was found for the mental health conditions where the

odds of trouble sleeping is 67% lower among those who do not have a mood disorder and 65% lower among those who do not have an anxiety disorder than those who have these conditions.

Adjusted Odds Ratio

Six ordinal logistic regression models were run on the unweighted sample (Table 3) where in the second model impact of income was shown after adjusting for sociodemographic variables- age, sex, marital status, kids under 12 years of age in the household, immigration status, race. After adjusting for all sociodemographic variables, the odds of having trouble sleeping was accelerated a bit for income, still, it was statistically significant for all categories. For the income group of \$20,000 to \$39,999, the odds of trouble sleeping were 9% lower than the lowest income group. Whereas for the \$40,000 to \$59,999 income group, odds of trouble sleeping is 12% lower and for the \$60,000 to \$79,999 income group, odds are 14% lower than the no income or less than \$20,000 income group. For \$80,000 or more, the odds of trouble sleeping is 11% lower than the lowest income group. Odds of trouble sleeping remained higher for females (OR=1.7), widowed/divorced/separated (OR=1.1), non-immigrant Canadian (OR=1.14), age group between 45-64 years. Interestingly, the higher odds ratio for trouble sleeping for two more age groups between 35-44 (OR=1.2) became significant, whereas lower odds of trouble sleeping (23%) for 80 years and older groups became statistically significant. Also, lower odds for kids under 12 remained similar (-16%), but for non-whites, it was raised a little (-16%) and both remained significant.

After adjusting for all sociodemographic variables, other measures of socioeconomic status were entered in the third model- household education level, household ownership, household size by the number of persons. Odds of having trouble sleeping was attenuated more for income, still, it was statistically significant for all categories. For the income group of

\$20,000 to \$39,999, odds of trouble sleeping were 10% lower than the lowest income group. Whereas for the \$40,000 to \$59,999 income group, odds of trouble sleeping is 13.5% lower and for the \$60,000 to \$79,999 income group, odds are 15% lower than the no income or less than \$20,000 income group. For \$80,000 or more, the odds of trouble sleeping are 10% lower than the lowest income group, holding all other variables constant. Odds of trouble sleeping remained higher for females (OR=1.75), single and widowed/divorced/separated (OR=1.1), non-immigrant Canadian (OR=1.15), age group between 45-59 years. The previously higher odds ratio for trouble sleeping for three age groups between 35-44 and 60-64 became insignificant whereas odds of trouble sleeping for 80 years and older group remained lower (-26%) and statistically significant. Lower odds for kids under 12 and non-whites raised a little but remained significant. Regarding household education, those who had completed secondary school graduation or had a post-secondary certificate, diploma or university degree had higher odds (OR=1.12) of trouble sleeping than those who did not complete secondary school graduation. Impact of household ownership on sleep became insignificant whereas odds for household size increased for all groups though it was only significant for households having four and five persons.

In the fourth model, after adjusting for all sociodemographic and economic variables, lifestyle variables were included. From the findings, the odds of having trouble sleeping remained the same as before for the income being statistically significant for all categories. For the income group of \$20,000 to \$39,999, odds of trouble sleeping was 10% lower than the lowest income group. Whereas for \$40,000 to \$59,999 income group, odds of trouble sleeping is 14% lower and for \$60,000 to \$79,999 income group odds is 15% lower than the no income or less than \$20,000 income group. For \$80,000 or more, odds of trouble sleeping is 11% lower than the

lowest income group. On the other hand, odds of trouble sleeping remained still higher for female (OR=1.8), widowed/divorced/separated (OR=1.1) though moderately significant, and single (OR=1.1), non-immigrant Canadian (OR=1.13), age group between 45-59 years (OR=1.3~1.4). Higher odds for previously reported household education remained the same for the higher education level (OR=1.1). The impact of household size was more accelerated and significant for households having four (-12%) and five persons (-10.7%). For the effect of smoking and drinking alcohol, the odds of trouble sleeping increased than before (-13% and -11%) which is statistically significant.

In the fifth model, after adjusting for all sociodemographic, socioeconomic, and lifestyle variables, physical health-related variables were entered into the model. Results showed that the odds of having trouble sleeping for two higher-income groups increased than before while for the \$60,000 to \$79,999 income group odds is 1.005 times higher than the no income or less than \$20,000 income group and for \$80,000 or more, odds of trouble sleeping is 1.06 times higher than the lowest income group though the findings were statistically insignificant for all categories. The odds of trouble sleeping remained higher for females (OR=1.8), while for widowed/divorced/separated (OR=1.1) became insignificant and for single (OR=1.1) it was barely significant. For non-immigrant Canadian odds for trouble sleeping remained higher (OR=1.12). For the age group between 50-54 years, the odds ratio remained higher (OR=1.2), whereas for other groups that were previously significant became insignificant after adjusting for health conditions. Also, odds of trouble sleeping started to decline from the age group of 65 to 80 years and older against the age group of 18-19 years and remained statistically significant. The effect of smoking became insignificant and the odds of trouble sleeping for non-drinkers were lower than before (-22.8%) but statistically significant. Odds of trouble sleeping for not being

physically active declined more (-21%) than those who were active up to the recommended level. For the chronic health conditions, odds of trouble sleeping were lower among those who did not have asthma (-16%), high blood pressure (-5%), arthritis (-29%), whereas it was unexpectedly 1.1 times higher among non-diabetics (OR=1.1). For each decreasing level of perceived general health odds of trouble sleeping increased against perceived “Excellent” health (OR for "Very good" =1.5, OR= 2.1 for "Good"; OR= 3.5 for "Fair"; OR= 8 for "Poor").

Lastly, in the final model, mental health-related variables were added and it could be seen that the odds of having trouble sleeping for all income groups increased than before although the finding was statistically significant only for the highest income group (\$80,000 or more) where odds of trouble sleeping is 1.12 times higher than the lowest income group. Odds of trouble sleeping remained higher although a bit attenuated for females (OR=1.7), while for all groups of marital status the odds became insignificant. For the age group between 50-54 years, odds ratio remained higher (OR=1.2). Furthermore, lower odds of trouble sleeping for the age groups of 70-74, 75-79, and 80 years and older against the age group of 18-19 years remained statistically significant (-18%, -22.4% & -33.7% respectively). For non-immigrant Canadian odds for trouble sleeping remained higher (OR=1.1). Odds of trouble sleeping for non-whites increased a little more than the previous model but remained significant (-9%). Interestingly, trouble sleeping odds for higher education groups still remained higher in the fully adjusted model (OR=1.2). For the household size, the odds were lower than before for households having four and five persons (-16% & -14.7% respectively). The effect of smoking remained insignificant and odds of trouble sleeping for non-drinkers (-23%) and occasional drinkers (-7%) was lower than before but statistically significant. Odds of trouble sleeping for not being physically active declined more (-19%) than those who were active up to the recommended level. Odds of trouble sleeping

remained lower among those who did not have asthma (-13.8%), high blood pressure (-6.7%), arthritis (-29%) whereas higher odds among non-diabetics (OR=1.1) became insignificant. For perceived general health, odds of trouble sleeping decreased than before but still remained higher (OR =1.3 for “Very good”; OR= 1.5 for “Good”; OR= 2.2 for “Fair”; OR= 4.1 for “Poor”. For those who did not have any mood disorder odds of trouble sleeping were 26.6% lower than those who had; similarly, for anxiety disorder, odds were lower for those who did not have any anxiety disorder (-31.3%). For each decreasing level of perceived mental health odds of trouble sleeping increased as follows- OR for “Very good”, “Good”, “Fair”, “Poor” were respectively 1.3, 1.7, 2.4, and 3.2 times higher than perceived “Excellent” mental health.

Discussion

This study aimed at examining the association between income and sleep quality as well as investigating whether socioeconomic sleep disparity could be explained by overall health conditions. Our analysis shows a similar pattern of sleep disturbance reported by previous research on many points while outlining several differences. For example, females had more sleep problems than males which were significant in all of the models as reported by other studies (Sekine et al., 2006; Arber et al., 2009). It was also evident that the increasing age contributes to more sleep troubles until a certain age, in our study the peak sleep trouble was prevalent among 50-54 years old. However, the likelihood of trouble sleeping decreased with further increase in age, especially among the 80 years and older it was the least which can be backed up by only a few prior studies (Moore et al., 2002; Whinnery et al., 2013). For the marital status, trouble sleeping was more likely among singles and those who are previously married (widowed/divorced/separated) (Whinnery et al., 2013) which was completely mediated after controlling for mental health factors. As the sample was categorized into “Whites” and “Non-

whites” on the racial background, it was not possible to distinguish sleep disparity among other ethnic groups, still, whites showed more likelihood of suffering from sleep disturbance than non-whites, which is quite surprising as most of the studies report poor sleep among non-white minorities which can be explained by their lower socioeconomic condition or perceived lower social status (Williams et al., 2009; Goodin et al., 2010). Immigrants were less likely to have trouble sleeping than non-immigrants which can be attributed to the previous study findings that immigrants supposedly report fewer sleep symptoms (Seicean et al. 2011; Grandner et al., 2013). Smokers had more difficulty in sleeping than non-smokers even after adjusting for other socioeconomic, sociodemographic, and lifestyle factors which were no longer significant after adding health factors in the model supporting similar studies (McNamara et al., 2014). Similarly, occasional drinkers and non-drinkers of alcohol were less likely to have sleep problems than regular ones but unlike smoking, it remained significant even in the fully adjusted model (I McFarlane, 2018). The lower likelihood of trouble sleeping among those who were either physically less active or not active than those physically active at or above the recommended level by the Canadian Physical Activity guideline was in contrast with previous studies (Vancampfort et al., 2018). In the final model, all of the categories of perceived general and mental health showed significant association with sleep disturbance against those who perceived excellent physical and mental health. Additionally, several chronic conditions were more likely to disrupt sleep including asthma, high blood pressure, and most significantly arthritis which could be explained by the pain associated with the disease (Louie et al., 2011). Another two most significant associations of trouble sleeping are mental health conditions - mood and anxiety disorders which also supports previous research findings (Louie et al., 2011).

However, this study extends on past research and provides some newer insights. To reveal those we will first address the research questions that we are intending to answer through this study. From the analysis, it could be seen that poor sleep was strongly associated with household income both independently and even after adjusting for all other variables. Although initially, the likelihood of having trouble sleeping was decreasing with an increase in income, later adjusted models showed a different result. After controlling for all other sociodemographic, socioeconomic, lifestyle, and health variables, although the likelihood of sleep disturbance among other income groups was mediated, a higher likelihood of sleep problem among the highest income group who had household income more than \$80,000 yearly persisted. This finding mostly contradicts other studies that showed that higher income groups usually have good sleeping patterns (Moore et al., 2002). Although it is a relatively controversial finding it might not be the first as Patel et al. (2009) found that solvent African-Americans were more likely to have trouble sleeping than their White counterparts and impoverished African-Americans. This could also mean that higher-income might not be as protective as it is thought to be against poor sleeping.

Apart from household income, other socioeconomic factors also showed a significant association with sleep independently but in a different way. Unexpectedly, those with higher education levels were more likely to have sleep problems even in the fully adjusted model. This was a counterintuitive finding as previous literature showed a positive relation of sleep with education where lower education level was associated with poor sleep (Gellis et al., 2005). The possible reason for this variation could be that higher education is associated with higher income (Moore et al., 2002) and thus showing a similar association for sleep disturbance as the higher income group. Additionally, household size was an important determinant of sleep disturbance

where households with more persons reported better sleep than single householders specifically those who had four to five or more family members. This was also contrary to previous findings that suggested an increased number of people in the household leads to poor sleep (Williams et al, 2009). This could be linked to the feeling of loneliness in a single household which may result in poor sleep (Matthews et al., 2017). Still, it gives a new insight into another component of socioeconomic factors that could be a significant indicator of poor sleep which needs further exploration. Although those who lived in rented houses were more likely to have poor sleep in absence of other factors, it was completely mediated after adjusting for other socio-demographic and socio-economic factors.

To answer the second research question, we showed that in the second and third model even after adjusting for sociodemographic and lifestyle variables significant independent association between several socioeconomic factors and sleep persisted which was completely abolished for all income categories after controlling for health-related variables including chronic disease conditions and perceived health status. However, in the final model, after adjusting for mental disease conditions like mood disorders and anxiety disorders along with perceived mental status, still the association between sleep and income remained insignificant for relatively lower-income groups except for the highest income group of \$80K and more which revealed significant association. It implies that the socio-economic discrepancies of sleep can be explained by health-related factors, but only for lower-income groups. Mediation of sleep discrepancies for lower-income groups by health-related factors supports past research (Patel et al., 2010; Arber et al., 2009). It could be linked to the knowledge that lower socioeconomic positions are often associated with poor health status (Wang & Geng, 2019) and psychological distress which in turn lead to poor sleep. However, for higher-income groups health status could

not explain the difficulty in sleeping which further intrigues the question of possible reasons or factors for this association. Although it was suggested long ago that higher wages might reduce sleep time (Biddle & Hamermesh, 1990) but could it be the same for sleep quality? This warrants further research in the future to have a better understanding of this matter.

Limitations

Although the study sample consisted of 113290 respondents, around half of them answered the question of trouble sleeping which excluded Ontario, Manitoba, Saskatchewan, still, it was a large enough sample to analyze the data properly. The analysis was done on an unweighted sample which hinders the generalization of the findings to the whole population. Nonetheless, it provided some reliable significant findings which were supported by previous research. The relation between SES, sleep, and health is often considered as confounding as there is a lack of understanding of the direction of their relations. However, in the study, we conducted the analysis in a logical series based on past knowledge to show the mediating effect of health status on SES-sleep disparity. Still, we recognize the limitation that there might be other possible significant physical and psychosocial factors that were not included in the study but could influence sleep quality.

Conclusion

Adverse effects of poor sleep not only affects the health of a person, it also negatively affects the family, society, and the national economy. Ongoing research on sleep has identified several important determinants of poor sleep quality. This study adds to the current knowledge on sleep by pointing out that while lower socioeconomic groups may be vulnerable to sleep disparity higher income groups might not be immune to sleep problems. Moreover, this socioeconomic difference in sleep can be explained for lower-income groups by physical and

mental health status whereas it remains unexplained among the higher income groups. The practical implication of this finding is that it implies a poor health status among lower-income groups, which leads to poor sleep quality among them and it could be improved by ensuring proper interventions to address the health inequality among impoverished populations. For the finding related to well-off groups further exploration is needed. Apart from these, a few other incidental findings have warranted consideration such as the inverse relation between sleep and education, physical activity, household density in terms of the number of persons. For a better understanding of these questions and identification of the underlying causal and influencing factors, we encourage further investigation in this matter.

References

- Adams J. (2006). Socioeconomic position and sleep quantity in UK adults. *Journal of epidemiology and community health*, 60(3), 267–269.
<https://doi.org/10.1136/jech.2005.039552>
- Arber, S., Bote, M., & Meadows, R. (2009). Gender and socio-economic patterning of self-reported sleep problems in Britain. *Social Science and Medicine*, 68(2), 281–289.
<https://doi.org/10.1016/j.socscimed.2008.10.016>
- Biddle, J., & Hamermesh, D. (1990). Sleep and the Allocation of Time. *Journal of Political Economy*, 98(5), 922-943. Retrieved November 8, 2020, from
<http://www.jstor.org/stable/2937618>
- Cappuccio, F. P., D'Elia, L., Strazzullo, P., & Miller, M. A. (2010). Sleep duration and all-cause mortality: a systematic review and meta-analysis of prospective studies. *Sleep*, 33(5), 585–592. <https://doi.org/10.1093/sleep/33.5.585>
- Centers for Disease Control and Prevention (CDC). Effect of short sleep duration on daily activities--United States, 2005-2008. *MMWR Morb Mortal Wkly Rep*. 2011 Mar 4;60(8):239-42. PMID: 21368739.
- Chen, J. H., Waite, L. J., & Lauderdale, D. S. (2015). Marriage, Relationship Quality, and Sleep among U.S. Older Adults. *Journal of health and social behavior*, 56(3), 356–377.
<https://doi.org/10.1177/0022146515594631>

- Colten HR, Altevogt BM, Institute of Medicine Committee on Sleep Medicine and Research. Sleep disorders and sleep deprivation: an unmet public health problem. Washington, DC: Institute of Medicine: National Academies Press; 2006. PMID: 20669438.
- Crummy, F., Piper, A. J., & Naughton, M. T. (2008). Obesity and the lung: 2 ? Obesity and sleep-disordered breathing. *Thorax*, 63, 738–746.
<https://doi.org/10.1136/thx.2007.086843>
- Davidson, J. R., Maclean, A. W., Brundage, M. D., & Schulze, K. (2002). Sleep disturbance in cancer patients. In *Social Science & Medicine* (Vol. 54).
[https://doi.org/10.1016/S0277-9536\(01\)00043-0](https://doi.org/10.1016/S0277-9536(01)00043-0)
- Dinges, D. F. (1995). An overview of sleepiness and accidents. *Journal of Sleep Research*, 4, 4–14. <https://doi.org/10.1111/j.1365-2869.1995.tb00220.x>
- Fang HF, Miao NF, Chen CD, Sithole T, Chung MH. Risk of Cancer in Patients with Insomnia, Parasomnia, and Obstructive Sleep Apnea: A Nationwide Nested Case-Control Study. *J Cancer*. 2015 Sep 15;6(11):1140-7. doi: [10.7150/jca.12490](https://doi.org/10.7150/jca.12490). PMID: 26516362; PMCID: PMC4615350
- Fox, E. C., Wang, K., Aquino, M., Grandner, M. A., Xie, D., Branas, C. C., & Gooneratne, N. S. (2018). Sleep debt at the community level: impact of age, sex, race/ethnicity and health. *Sleep health*, 4(4), 317–324. <https://doi.org/10.1016/j.sleh.2018.05.007>
- Galobardes, B., Shaw, M., Lawlor, D. A., Lynch, J. W., & Smith, G. D. (2006). Indicators of socioeconomic position (part 1). In *Journal of Epidemiology and Community Health*

(Vol. 60, Issue 1, pp. 7–12). BMJ Publishing Group.

<https://doi.org/10.1136/jech.2004.023531>

Gellis, L. A., Lichstein, K. L., Scarinci, I. C., Durrence, H. H., Taylor, D. J., Bush, A. J., & Riedel, B. W. (2005). Socioeconomic Status and Insomnia. *Journal of Abnormal Psychology*, 114(1), 111–118. <https://doi.org/10.1037/0021-843X.114.1.111>

Goodin, B. R., McGuire, L., & Smith, M. T. (2010). Ethnicity Moderates the Influence of Perceived Social Status on Subjective Sleep Quality. *Behavioral Sleep Medicine*, 8(4), 194–206. <https://doi.org/10.1080/15402002.2010.509193>

Heslop, P., Smith, G. D., Metcalfe, C., Macleod, J., & Hart, C. (2002). Sleep duration and mortality: the effect of short or long sleep duration on cardiovascular and all-cause mortality in working men and women. Retrieved November 1, 2020, from www.elsevier.com/locate/sleep

Hillman, D. R., & Lack, L. C. (2013). Public health implications of sleep loss: the community burden. *Medical Journal of Australia*, 199(S8), S7–S10. <https://doi.org/10.5694/mja13.10620>

Hirshkowitz, M., Whiton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., Hazen, N., Herman, J., Katz, E. S., Kheirandish-Gozal, L., Neubauer, D. N., O'Donnell, A. E., Ohayon, M., Peever, J., Rawding, R., Sachdeva, R. C., Setters, B., Vitiello, M. V., Ware, J. C., ... Adams Hillard, P. J. (2015). National sleep Foundation's sleep time duration recommendations: Methodology and results summary. *Sleep Health*, 1(1), 40–43. <https://doi.org/10.1016/j.sleh.2014.12.010>

Howard M. Kravitz, DO, MPH, Xinhua Zhao, MS, Joyce T. Bromberger, PhD, Ellen B.

Gold, PhD, Martica H. Hall, PhD, Karen A. Matthews, PhD, MaryFran R. Sowers,

PhD, Sleep Disturbance During the Menopausal Transition in a Multi-Ethnic

Community Sample of Women, *Sleep*, Volume 31, Issue 7, July 2008, Pages 979–990,

<https://doi.org/10.5665/sleep/31.7.979>

I McFarlane, S. (2018). Sleep health disparity: the putative role of race, ethnicity and

socioeconomic status. *Sleep Medicine and Disorders: International Journal*, 2(5), 127.

<https://doi.org/10.15406/smdij.2018.02.00057>

Knutson, K. L. (2013). *Sociodemographic and cultural determinants of sleep deficiency:*

Implications for cardiometabolic disease risk.

<https://doi.org/10.1016/j.socscimed.2012.05.002>

Kripke DF, Simons RN, Garfinkel L, Hammond EC. Short and long sleep and sleeping

pills. Is increased mortality associated? *Arch Gen Psychiatry*. 1979 Jan;36(1):103-16.

doi: 10.1001/archpsyc.1979.01780010109014. PMID: 760693.

Louie, G. H., Tektonidou, M. G., Caban-Martinez, A. J., & Ward, M. M. (2011). Sleep

disturbances in adults with arthritis: prevalence, mediators, and subgroups at greatest

risk. Data from the 2007 National Health Interview Survey. *Arthritis care & research*,

63(2), 247–260. <https://doi.org/10.1002/acr.20362>

Matthews, T., Danese, A., Gregory, A., Caspi, A., Moffitt, T., & Arseneault, L. (2017).

Sleeping with one eye open: Loneliness and sleep quality in young adults.

Psychological Medicine, 47(12), 2177-2186. doi:10.1017/S0033291717000629

McNamara, J. P. H., Wang, J., Holiday, D. B., Warren, J. Y., Paradoa, M., Balkhi, A. M.,

Fernandez-Baca, J., & McCrae, C. S. (2014). Sleep disturbances associated with cigarette smoking. *Psychology, Health & Medicine*, 19(4), 410–419.

<https://doi.org/10.1080/13548506.2013.832782>

Medic, G., Wille, M., & Hemels, M. E. H. (2017). Short- and long-term health

consequences of sleep disruption. In *Nature and Science of Sleep* (Vol. 9, pp. 151–161). Dove Medical Press Ltd. <https://doi.org/10.2147/NSS.S134864>

Michal M, Wiltink J, Kirschner Y, Schneider A, Wild PS, Münzel T, Blettner M, Schulz A,

Lackner K, Pfeiffer N, Blankenberg S, Tschan R, Tuin I, Beutel ME. Complaints of sleep disturbances are associated with cardiovascular disease: results from the

Gutenberg Health Study. *PLoS One*. 2014 Aug 5;9(8):e104324. doi:

10.1371/journal.pone.0104324. PMID: 25093413; PMCID: PMC4122446.

Moore, P. J., Adler, N. E., Williams, D. R., & Jackson, J. S. (2002). Socioeconomic status

and health: The role of sleep. *Psychosomatic Medicine*, 64(2), 337–344.

<https://doi.org/10.1097/00006842-200203000-00018>

Nomura, K., Yamaoka, K., Nakao, M., & Yano, E. (2010). Social determinants of self-

reported sleep problems in South Korea and Taiwan. *Journal of Psychosomatic*

Research, 69(5), 435–440. <https://doi.org/10.1016/j.jpsychores.2010.04.014>

Oh, C. M., Kim, H. Y., Na, H. K., Cho, K. H., & Chu, M. K. (2019). The Effect of Anxiety

and Depression on Sleep Quality of Individuals With High Risk for Insomnia: A

- Population-Based Study. *Frontiers in neurology*, 10, 849.
<https://doi.org/10.3389/fneur.2019.00849>
- Ohayon MM, Carskadon MA, Guilleminault C, Vitiello MV. Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. *Sleep*. 2004 Nov 1;27(7):1255-73.
[doi: 10.1093/sleep/27.7.1255](https://doi.org/10.1093/sleep/27.7.1255). PMID: 15586779
- Pampel, F. C., Krueger, P. M., & Denney, J. T. (2010). Socioeconomic Disparities in Health Behaviors. *Annual review of sociology*, 36, 349–370.
<https://doi.org/10.1146/annurev.soc.012809.102529>
- Patel, S. R., Malhotra, A., Gottlieb, D. J., White, D. P., & Hu, F. B. (2006). Correlates of long sleep duration. *Sleep*, 29(7), 881–889. <https://doi.org/10.1093/sleep/29.7.881>
- Patel, N. P., Grandner, M. A., Xie, D., Branas, C. C., & Gooneratne, N. (2010). “Sleep disparity” in the population: Poor sleep quality is strongly associated with poverty and ethnicity. *BMC Public Health*, 10(1), 475. <https://doi.org/10.1186/1471-2458-10-475>
- Pilcher JJ, Ginter DR, Sadowsky B. Sleep quality versus sleep quantity: relationships between sleep and measures of health, well-being and sleepiness in college students. *J Psychosom Res*. 1997 Jun;42(6):583-96. doi: 10.1016/s0022-3999(97)00004-4. PMID: 9226606.
- Sabanayagam C, Shankar A. Sleep duration and cardiovascular disease: results from the National Health Interview Survey. *Sleep* 2010; **33**: 1037–1042.

- Sekine M, Chandola T, Martikainen P, Marmot M, Kagamimori S. Work and family characteristics as determinants of socioeconomic and sex inequalities in sleep: The Japanese Civil Servants Study. *Sleep*. 2006 Feb;29(2):206-16. doi: 10.1093/sleep/29.2.206. PMID: 16494089.
- Sigurdardottir LG, Valdimarsdottir UA, Mucci LA, et al. Sleep disruption among older men and risk of prostate cancer. *Cancer Epidemiol Biomarkers Prev*. 2013;22(5):872–879.
- Sinziana Seicean, MD, MPH, PhD, Duncan Neuhauser, PhD, Kingman Strohl, MD, Susan Redline, MD, MPH, An Exploration of Differences in Sleep Characteristics between Mexico-born US Immigrants and Other Americans to Address the Hispanic Paradox, *Sleep*, Volume 34, Issue 8, 1 August 2011, Pages 1021–1031, <https://doi.org/10.5665/SLEEP.1154>
- Spiegel K, Knutson K, Leproult R, Tasali E, Van Cauter E. Sleep loss: a novel risk factor for insulin resistance and Type 2 diabetes. *J Appl Physiol* (1985). 2005 Nov;99(5):2008-19. doi: 10.1152/japplphysiol.00660.2005. PMID: 16227462.
- Spiegel K, Tasali E, Penev P, Van Cauter E (2004b) Brief communication: sleep curtailment in healthy young men is associated with decreased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Ann Intern Med* 141(11):846– 850.
- Sridhar GR, Madhu K. Prevalence of sleep disturbances in diabetes mellitus. *Diabetes Res Clin Pract*. 1994 Apr;23(3):183-6. doi: 10.1016/0168-8227(94)90103-1. PMID: 7924879.

- Stamatakis, K. A., Kaplan, G. A., & Roberts, R. E. (2007). Short Sleep Duration Across Income, Education, and Race/Ethnic Groups: Population Prevalence and Growing Disparities During 34 Years of Follow-Up. *Annals of Epidemiology*, 17(12), 948–955. <https://doi.org/10.1016/j.annepidem.2007.07.096>
- Statistics Canada. 2018. Canadian Community Health Survey (CCHS), 2017-2018, (subset compiled from public-use microdata file). Statistics Canada (producer). Using IDLS (distributor). <http://janus.ssc.uwo.ca/idls/> (accessed October 16, 2020). Raw data, 84.0 KB, 113290 cases, 23 variables. Accompanying documentation: user guide and questionnaire (PDF). All computations, use and interpretation of these data are entirely those of the author.
- Stein, M. D., & Friedmann, P. D. (2006). Disturbed Sleep and Its Relationship to Alcohol Use. *Substance Abuse*, 26(1), 1–13. https://doi.org/10.1300/J465v26n01_01
- Tkachenko, O., Olson, E. A., Weber, M., Preer, L. A., Gogel, H., & Killgore, W. D. S. (2014). Sleep difficulties are associated with increased symptoms of psychopathology. *Experimental Brain Research*, 232(5), 1567–1574. <https://doi.org/10.1007/s00221-014-3827-y>
- Vancampfort, D., Stubbs, B., Smith, L., Hallgren, M., Firth, J., Herring, M. P., Probst, M., & Koyanagi, A. (2018). Physical activity and sleep problems in 38 low- and middle-income countries. *Sleep Medicine*, 48, 140–147. <https://doi.org/10.1016/j.sleep.2018.04.013>

- Vgontzas AN, Liao D, Bixler EO, et al. Insomnia with objective short sleep duration is associated with a high risk for hypertension. *Sleep* 2009; **32**: 491–497
- Wang, J., & Geng, L. (2019). Effects of Socioeconomic Status on Physical and Psychological Health: Lifestyle as a Mediator. *International journal of environmental research and public health*, 16(2), 281. <https://doi.org/10.3390/ijerph16020281>
- Watanabe M, Kikuchi H, Tanaka K, Takahashi M (2010) Association of short sleep duration with weight gain and obesity at 1-year follow-up: a large-scale prospective study. *Sleep* 33(2):161–167
- Watson, N. F., Badr, M. S., Belenky, G., Bliwise, D. L., Buxton, O. M., Buysse, D., Dinges, D. F., Gangwisch, J., Grandner, M. A., Kushida, C., Malhotra, R. K., Martin, J. L., Patel, S. R., Quan, S. F., Tasali, E., Twery, M., Croft, J. B., Maher, E., Barrett, J. A., ... Heald, J. L. (2015). Joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society on the recommended amount of sleep for a healthy adult: Methodology and discussion. *Sleep*, 38(8), 1161–1183. <https://doi.org/10.5665/sleep.4886>
- Williams, E., Steptoe, A., Chambers, J., & Kooner, J. (2009). Psychosocial risk factors for coronary heart disease in UK South Asian men and women. *Journal of Epidemiology and Community Health* (1979-), 63(12), 986-991. Retrieved December 17, 2020, from <http://www.jstor.org/stable/20721106>

Appendix

Table 1: Sample Characteristics of CCHS data

(N= 41,144)		Trouble Sleeping (%)				
All Variable		Never	Rarely	Sometimes	Most of the Time	All of the Time
Socio Demographic Factors						
Sex						
Male		28.8	29.3	26.7	10.2	5
Female		18.5	25.7	32.8	15.8	7.2
Marital Status						
Married		24.1	27.8	30.7	12.1	5.2
Common law		24	29.2	28.3	13.4	5.2
Widowed/Divorced/Separated		22.9	25.3	29.6	14.1	8.1
Single		22.2	27.5	29.8	14	6.6
Age						
18 - 19		22	31.1	31.4	11.5	4
20 - 24		23.2	29.9	28.4	13.4	5
25 - 29		24.5	29.7	28.6	12.5	4.7
30 - 34		24.5	28.4	29.6	12	5.5
35 - 39		23.9	28.8	28.8	13.5	5
40 - 44		23.2	29.1	29.8	12.2	5.7
45 - 49		21.4	28.1	29.3	14.4	6.9
50 - 54		19.5	24.5	32.4	15.6	7.9
55 - 59		20.1	25.7	31.7	14.4	7.9
60 - 64		21.9	26.6	30.3	14.2	7
65 - 69		23.2	28.1	29.6	13	6.1
70 - 74		25.3	27.2	29.6	12.4	5.5
75 - 79		28.1	24.6	29.4	11.5	6.4
80 - older		30	24.5	29.5	10.4	5.6
Kids Under 12						
No		22.8	27.2	30.4	13.2	6.5
Yes		26.1	28.3	27.8	13	4.8
Immigrant Status						
Landed immigrant / Non-Permanent resident		27.8	25.3	32.3	10.2	4.4
Non Immigrant / Canadian born		22.4	27.9	29.4	13.8	6.6
Race						
White		22.6	27.8	29.5	13.6	6.5
Non white		28.7	25	32.4	10	3.9

Socio Economic Factors					
Household Income					
< \$20.000/ No Income	25.4	22.6	25.9	15.4	10.8
\$20.000 - \$39.999	25.2	24.5	29.2	14.1	7
\$40.000 - \$59.999	24.3	26.1	30.5	13.1	5.9
\$60.000 - \$79.999	23.8	28.3	29.9	12.3	5.7
\$80.000/more	21.9	29.6	30.7	12.6	5.1
Household Education Level					
< Secondary	30.3	21.3	26	13.5	8.9
Secondary to No post-secondary	24.5	25.3	28.5	13.8	8
> Post-secondary	22.3	28.6	30.7	13	5.4
Household Size(No. of persons)					
1	22.9	25.8	29.7	14	7.6
2	22.8	27.8	31	12.6	5.8
3	23.6	27.7	28.8	14.1	5.8
4	24.8	30.2	28.7	12.1	4.1
5 or more persons	27.1	27.8	29	11.3	4.9
Household Own					
Owned	22.6	28.6	30.5	12.9	5.4
Rented	25.3	24.5	28.6	13.7	8
Life Style Factors					
Type of Smoker					
Daily	25.7	22.5	25.5	15.6	10.7
Occasionally	22.1	26.1	30.9	14.5	6.4
Not at all	23.1	28.2	30.5	12.7	5.4
Type of Drinker					
Regular	22	28.7	30.8	13.2	5.4
Occasional	23.3	25.7	28.6	14.5	8
Not drink (12 months)	29.3	23.6	27.5	11.8	7.8
Physical Activity Indicator					
Physic active (\geq Level)	22.4	28.4	30.6	12.9	5.7
Physic active (< Level)	21.5	27.8	31	13.7	6
No physical activity	28.5	24	26.7	13.1	7.6
Physical Health Factors					
Has Asthma					
Yes	20.1	21.8	29	17.8	11.3
No	23.7	27.9	30	12.7	5.7
Has High Blood Pressure					

Yes	22.6	24.5	30.3	14.6	8
No	23.6	28.1	29.8	12.7	5.7
Has Heart Disease					
Yes	23.7	22.9	27.6	16.9	8.9
No	23.4	27.7	30.1	12.9	6
Has Diabetes					
Yes	25.6	23.7	26.4	15.1	9.2
No	23.2	27.7	30.2	13	5.9
Has Arthritis					
Yes	18.7	23.2	30.5	17.4	10.2
No	24.9	28.7	29.7	11.8	4.9
Perceived General Health					
Excellent	31.3	31.5	26.4	8.1	2.7
Very Good	22.4	30.4	31.9	11.7	3.7
Good	20.8	24.7	31.9	15.4	7.1
Fair	18.1	19	27	21.5	14.4
Poor	16.6	10.1	21.3	22.3	29.7
Mental Health Factors					
Has Mood Disorder					
Yes	12.8	17.8	27.2	24.4	17.8
No	24.4	28.3	30.2	12.1	5.1
Has Anxiety Disorder					
Yes	13.4	17.6	28.7	22.7	17.6
No	24.3	28.3	30	12.3	5.1
Perceived Mental Health					
Excellent	31.1	30.5	26.2	8.7	3.5
Very Good	21.7	29.8	32.1	12	4.4
Good	18.4	22.6	33.1	17.3	8.5
Fair	13.5	16	26.7	26.4	17.3
Poor	11.5	11.9	16.4	25.9	34.3

Table 2: Unadjusted Odd Ratio

(N=41,144)	Trouble Sleeping
All Variable	(Odds Ratio)
Socio Demographic Factors	
Sex	
Male	Referent
Female	1.729*** (0.018)
Marital Status	
Married	Referent
Common law	0.997 (0.027)
Widowed/Divorced/Separated	1.194*** (-0.024)
Single	1.137*** (0.023)
Age	
18 - 19	Referent
20 - 24	1.025 (0.078)
25 - 29	0.964 (0.075)
30 - 34	0.997 (0.074)
35 - 39	1.022 (0.074)
40 - 44	1.037 (0.075)
45 - 49	1.185** (0.075)
50 - 54	1.402*** (0.075)
55 - 59	1.322*** (0.073)
60 - 64	1.199** (0.073)
65 - 69	1.074 (0.073)
70 - 74	0.996 (0.074)
75 - 79	0.949 (0.078)
80 - older	0.863* (0.077)
Kids Under 12	
No	0.844*** (0.023)
Yes	Referent
Immigrant Status	

Landed immigrant / Non-Permanent resident	Referent
Non Immigrant / Canadian born	1.259*** (0.023)
Race	
White	Referent
Non white	0.770*** (0.026)
Socio Economic Factors	
Household Income	
< \$20.000/ No Income	Referent
\$20.000 - \$39.999	0.877*** (0.038)
\$40.000 - \$59.999	0.847*** (0.038)
\$60.000 - \$79.999	0.812*** (0.039)
\$80.000/more	0.843*** (0.034)
Household Education Level	
< Secondary	Referent
Secondary to No post- secondary	1.129*** (0.038)
> Post-secondary	1.076** (0.032)
Household Size(No. of persons)	
1	Referent
2	0.914*** (0.021)
3	0.908*** (0.030)
4	0.785*** (0.030)
5 or more persons	0.759*** (0.040)
Household Own	
Owned	Referent
Rented	1.048** (0.020)
Life Style Factors	
Type of Smoker	
Daily	Referent
Occasionally	0.951 (0.049)

Not at all	0.843*** (0.028)
Type of Drinker	
Regular	Referent
Occasional	1.086*** (0.025)
Not drink (12 months)	0.874*** (0.024)
Physical Activity Indicator	
Physic active (>=Level)	Referent
Physic active (< Level)	1.060*** (0.022)
No physical activity	0.908*** (0.023)
Physical Health Factors	
Has Asthma	
Yes	Referent
No	0.641*** (0.033)
Has High Blood Pressure	
Yes	Referent
No	0.836*** (0.022)
Has Heart Disease	
Yes	Referent
No	0.818*** (0.038)
Has Diabetes	
Yes	Referent
No	0.913*** (0.033)
Has Arthritis	
Yes	Referent
No	0.601*** (0.021)
Perceived General Health	
Excellent	Referent
Very Good	1.492*** (0.023)
Good	1.977*** (0.025)
Fair	3.260*** (0.037)
Poor	7.210*** (0.061)
Mental Health Factors	

Has Mood Disorder	
Yes	Referent
No	0.326*** (0.033)
Has Anxiety Disorder	
Yes	Referent
No	0.348*** (0.034)
Perceived Mental Health	
Excellent	Referent
Very Good	1.505*** (0.021)
Good	2.293*** (0.024)
Fair	4.626*** (0.043)
Poor	10.100*** (0.089)

Table 3: Adjusted Odds Ratio

	Model 1 <i>Household Income</i>	Model 2 <i>Socio Demographic</i>	Model 3 <i>Socio Economic</i>	Model 4 <i>Life Style</i>	Model 5 <i>Physical Health</i>	Model 6 <i>Mental Health</i>
Household Income						
No Income/< \$20.000	Ref	Ref	Ref	Ref	Ref	Ref
\$20.000 - \$39.999	0.877*** -0.038	0.906** -0.038	0.903*** -0.039	0.898*** -0.039	0.978 -0.039	1.02 -0.039
\$40.000 - \$59.999	0.847*** -0.038	0.873*** -0.039	0.865*** -0.04	0.859*** -0.04	0.974 -0.04	1.028 -0.04
\$60.000 - \$79.999	0.812*** -0.039	0.860*** -0.04	0.854*** -0.042	0.849*** -0.042	1.005 -0.043	1.071 -0.043
>=\$80.000	0.843*** -0.034	0.891*** -0.036	0.896*** -0.039	0.889*** -0.04	1.061 -0.04	1.138*** -0.04
Sex						
Male	--	Ref	Ref	Ref	Ref	Ref
Female	--	1.752*** -0.018	1.753*** -0.018	1.773*** -0.018	1.784*** -0.019	1.710*** -0.019
Marital Status						
Married	--	Ref	Ref	Ref	Ref	Ref
Common law	--	0.950* -0.028	0.942** -0.028	0.932** -0.028	0.933** -0.029	0.950* -0.029
Widowed/Divorced/Separated	--	1.101*** -0.026	1.095*** -0.034	1.082** -0.034	1.058 -0.034	1.025 -0.034
Single	--	1.118*** -0.028	1.106*** -0.035	1.095*** -0.035	1.066* -0.035	1.028 -0.035
Age						
18 - 19	--	Ref	Ref	Ref	Ref	Ref
20 - 24	--	1.031 -0.079	0.991 -0.079	0.986 -0.079	1.007 -0.079	1.008 -0.079
25 - 29	--	1.033 -0.077	0.961 -0.08	0.96 -0.08	0.95 -0.08	0.961 -0.08
30 - 34	--	1.148* -0.076	1.072 -0.081	1.067 -0.081	1.019 -0.081	1.022 -0.081
35 - 39	--	1.180** -0.077	1.114 -0.081	1.111 -0.081	1.034 -0.081	1.038 -0.081
40 - 44	--	1.188** -0.077	1.13 -0.081	1.133 -0.081	1.026 -0.081	1.045 -0.081
45 - 49	--	1.316*** -0.078	1.257*** -0.081	1.264*** -0.081	1.095 -0.081	1.118 -0.081
50 - 54	--	1.473***	1.397***	1.413***	1.174**	1.217**

		-0.077	-0.081	-0.081	-0.081	-0.081
55 - 59	--	1.339***	1.260***	1.282***	1.033	1.106
		-0.077	-0.081	-0.081	-0.082	-0.082
60 - 64	--	1.191**	1.117	1.146*	0.883	0.964
		-0.077	-0.082	-0.082	-0.083	-0.083
65 - 69	--	1.077	1.012	1.046	0.799***	0.904
		-0.077	-0.082	-0.082	-0.083	-0.083
70 - 74	--	0.979	0.924	0.971	0.719***	0.818**
		-0.08	-0.084	-0.084	-0.086	-0.086
75 - 79	--	0.913	0.873	0.927	0.673***	0.776***
		-0.083	-0.088	-0.088	-0.09	-0.09
80 - older	--	0.766***	0.740***	0.808**	0.580***	0.663***
		-0.083	-0.088	-0.089	-0.091	-0.091
Kids Under 12						
Yes		Ref	Ref	Ref	Ref	Ref
No	--	0.842***	0.912**	0.913**	0.938*	0.948
		-0.029	-0.036	-0.036	-0.036	-0.036
Immigrant Status						
Yes		Ref	Ref	Ref	Ref	Ref
No	--	1.139***	1.146***	1.136***	1.115***	1.087***
		-0.029	-0.03	-0.03	-0.03	-0.03
Race						
White		Ref	Ref	Ref	Ref	Ref
Non white	--	0.841***	0.847***	0.873***	0.876***	0.911***
		-0.034	-0.035	-0.035	-0.035	-0.035
Household Education Level						
< Secondary School			Ref	Ref	Ref	Ref
Secondary school but no post-secondary	--	--	1.121***	1.107***	1.183***	1.170***
			-0.039	-0.039	-0.04	-0.04
Post-secondary /university degree	--	--	1.122***	1.111***	1.231***	1.218***
			-0.035	-0.036	-0.036	-0.036
Household Size						
No. of persons: 1	--	--	Ref	Ref	Ref	Ref
No. of persons: 2	--	--	1.007	1.008	0.971	0.964
			-0.032	-0.032	-0.032	-0.032
No. of persons: 3	--	--	0.988	0.994	0.938	0.934*
			-0.04	-0.041	-0.041	-0.041
No. of persons: 4	--	--	0.869***	0.879***	0.836***	0.834***
			-0.047	-0.047	-0.047	-0.047
Grouped 5 or more persons	--	--	0.875**	0.893**	0.856***	0.853***
			-0.056	-0.056	-0.056	-0.056

Household Own						
Owned	--	--	Ref	Ref	Ref	Ref
Rented	--	--	1.032	1.028	0.989	0.98
			-0.023	-0.023	-0.023	-0.023
Type of Smoker						
Daily	--	--	--	Ref	Ref	Ref
Occasionally	--	--	--	1.018	1.071	1.085*
				-0.049	-0.049	-0.049
Not at all	--	--	--	0.870***	0.992	1.037
				-0.029	-0.029	-0.029
Type of Drinker						
Regular drinker	--	--	--	Ref	Ref	Ref
Occasional drinker	--	--	--	1.02	0.936**	0.933***
				-0.026	-0.026	-0.026
Did not (last 12 months)	--	--	--	0.884***	0.772***	0.767***
				-0.026	-0.027	-0.027
Physical Activity Indicator						
Physic active >= Level	--	--	--	Ref	Ref	Ref
Physic active < Level	--	--	--	1.028	0.954**	0.959*
				-0.022	-0.022	-0.022
No physical activity	--	--	--	0.912***	0.790***	0.809***
				-0.025	-0.025	-0.025
Has Asthma						
Yes	--	--	--	--	Ref	Ref
No	--	--	--	--	0.843***	0.862***
					-0.034	-0.034
Has High Blood Pressure						
Yes	--	--	--	--	Ref	Ref
No	--	--	--	--	0.948**	0.933***
					-0.025	-0.025
Has Heart Disease						
Yes	--	--	--	--	Ref	Ref
No	--	--	--	--	1.043	1.007
					-0.041	-0.041
Has Diabetes						
Yes	--	--	--	--	Ref	Ref
No	--	--	--	--	1.095**	1.05
					-0.036	-0.036
Has Arthritis						
Yes	--	--	--	--	Ref	Ref
No	--	--	--	--	0.704***	0.706***

					-0.024	-0.024
Perceived General Health						
Excellent	--	--	--	--	Ref	Ref
Very Good	--	--	--	--	1.483***	1.301***
					-0.024	-0.025
Good	--	--	--	--	2.068***	1.544***
					-0.026	-0.028
Fair	--	--	--	--	3.525***	2.193***
					-0.04	-0.042
Poor	--	--	--	--	7.913***	4.139***
					-0.064	-0.068
Has Mood Disorder						
Yes	--	--	--	--	--	Ref
No	--	--	--	--	--	0.734***
						-0.038
Has Anxiety Disorder						
Yes	--	--	--	--	--	Ref
No	--	--	--	--	--	0.687***
						-0.037
Perceived Mental Health						
Excellent	--	--	--	--	--	Ref
Very Good	--	--	--	--	--	1.325***
						-0.022
Good	--	--	--	--	--	1.713***
						-0.027
Fair	--	--	--	--	--	2.419***
						-0.048
Poor	--	--	--	--	--	3.186***
						-0.097
AIC	122911	121527	121508	121439	118933	117794

¹ Akaike information criterion

² P-values: *p<0.1; **p<0.05; ***p<0.01

³ Total Observations: 41,144

⁴ Data Source: Canadian Community Health Survey (2017-18)