Erasmus School of Economics

Bachelor Thesis Economics & Business Economics

Bedtime procrastination mediated sleep deficiency: Does socio-economic status influence this behavior?

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Abstract:

As sleep deficiency and sleeping disorders rise quickly in prevalence, it is recently regarded as a national health issue by the Centers for Disease Control and Prevention. With its severe aftereffects on an individual's health as well as risks for society, numerous campaigns are launched in order to prevent and aid individuals. Recent research discovered the significant relation of bedtime procrastination on sleep deficiency. And as socio-economic status plays a significant role in various health issues, it is plausible that socio-economic status also plays a significant role in bedtime procrastination and sleep deficiency. This socio-economic status will consist of four socio-economic variables of interest: education, income, occupation and neighbourhood density. Education, occupation and neighbourhood density show a positive statistical significant relation with both bedtime procrastination and sleep deficiency. Where a higher socio-economic position leads to higher reported bedtime procrastination and sleep deficiency. For income a negative statistical significant relation was found. When looking at the role of bedtime procrastination in the relationship between socio-economic variables and sleep deficiency, a partial mediation is found for income, occupation and neighbourhood density and a full mediation for education. Hence, bedtime procrastination plays an significant role in the relationship between socio-economic status and bedtime procrastination or sleep deficiency.

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Introduction

According to the Central Bureau of Statistics in the Netherlands, 25% of people above the age of 25 had sleep problems in 2018 making it a severe health issue (Slapen minstens zo belangrijk, 2019). However this problem does not contain itself to just the Netherlands. For instance, the CDC, Centers for Disease Control and Prevention in America reports that only 65% of their adult population experience a healthy sleep duration in 2014 (Chattu et al., 2019). Chronic disorders like breathing disorders, insomnia or substance/medicine induced sleep disorders contribute greatly to these numbers (The State of Sleephealth in America, n.d.). However, a substantial part of the sleep problems are due to sleep deprivation. These numbers grew dramatically when normal day-to-day life became more demanding and more intensive. The National Institute of Health predicts that in the mid of the 21st century, these numbers will rise to 100 million of the American population having sleep problems (The State of Sleephealth in America, n.d.). To fight this rapid growth among the global population, countless campaigns and projects have been initiated. From starting the conversation about sleep deprivation and the importance of having enough sleep to preventing the existence of this health problem. In order to help and guide people who experience these problems daily. The main problem of sleep deprivation and sleep deficiency is the unnoticed signs of exerting this behaviour and the lack of importance of this behaviour to these individuals. The key sign of sleep deficiency is tiredness during the day. Dozing off while for instance, reading, watching TV, conversating or driving for a period of time. Acknowledging sleep deficiency for people is however more a mental problem. People who experience the signs of sleep deficiency often justify the lack of sleep by stating they learn to live with less sleep and do not need to adjust their routine. However research rejects this justification and vouches for the importance of enough quality sleep (sleep deprivation and deficiency, n.d.).

The risks of sleep deficiency can be divided into two separate categories. The first category are effects on an individual scale which are described in detail by Chattu et al. (2019). Sleep deficiency leads to a change in overall mood and behaviour. With most noticeable irritability, frustration tolerance, nervousness and the drowsiness mentioned before. It also affects your ability to draw correct and fully informed conclusions. These premature conclusions might lead to unnecessary risk seeking in decisions and impact your moral judgement of situations because of the inability to see the full picture. Furthermore, it might affect your ability to learn, your memory and your overall cognitive performance. These conclusions were mostly drawn from studies under students and the impact on their academic results which showed a negative correlation between sleep deficiency and their

academic results. Besides these behavioural changes, sleep deficiency also impacts the individuals health severely. Sleep deficiency is shown to increase the risk of obesity and affects your metabolism. Finally, sleep deficiency is also shown to be connected to premature death by increased risk of several deathly diseases and conditions. It is shown to be connected to 7 out of 15 leading death causes in America. Besides the individual's risk, there are also risks and consequences on a societal level. Sleep deficiency and its complementary drowsiness reduces your driving ability significantly to the same point as being drunk. Increasing the amount of traffic accidents as well as overall work accidents (Klauer et al., 2006). Finally, sleep deficiency leads to major financial and economic losses. RAND corporation measured that up to 3% of GDP is lost due to lack of sleep (Why sleep matters, 2016). They estimated the loss for an European giant like Germany to be around 60 billion dollars and the loss for an economic set America to be around 411 billion dollars. These losses mostly originate from lower productivity, higher medical expenses, sick leave and environmental damage.

Most current literature focuses on the chronic disease side of sleep problems and sleep deficiency. However this paper will focus on the other side of the problem, which is bedtime procrastination since it is a significant yet under-researched and new field of interest for this health problem. The literature that does contribute to bedtime procrastination and sleep deficiency mostly focus on the aftereffect of this behaviour or the occupation that makes them act accordingly and does not look on an individual level which might dictate the prevalence and susceptibility of bedtime procrastination for a subgroup of the population. This paper will contribute to the motivation behind this behaviour by taking a closer look at socio-economic factors. This paper will contribute to this field of research by using the newly important health issue bedtime procrastination as a mediator for the effect of socio-economic variables on sleep deficiency. Using bedtime procrastination as a mediator will give insight into the role of bedtime procrastination in the relation between socio-economic variables and sleep deficiency. If a socio-economic variable has significant influence on sleep deficiency but does not show significance through bedtime procrastination, concludes that it is mediated through other possible aspects. However, when bedtime procrastination plays a significant role in the relationship between socio-economic factors and sleep deficiency, efforts of bedtime procrastination campaigns to a subgroup might contribute significantly more in reducing sleep deficiency. Hence, the main question this paper tries to answer is: *Does socio-economic status influence bedtime procrastination mediated sleep deficiency?*

The socio-economic variables that are traditionally chosen, to measure socio-economic status, are education, income and occupation (Ostrove & Adler, 1999). These

three variables also compose the Kuppuswamy scale which can be used to determine the socio-economic status of an individual (Singh et al., 2017). Those three variables are measured on an individual level, but Ostrove & Adler also propose income inequality and density of a neighbourhood as social variables of interest in determining someone's social status. These five variables of interest are also found by Kaplan & Keil (1993) who adds living conditions to the list which represents the materialistic options for an individual. Kaplan & Keil find an increase in all-cause mortality for lower levels of education, lower income and unemployed individuals which are also found in the paper of Ostrove & Adler (1999). Ostrove & Adler also state that areas with larger income inequality as well as areas with higher poverty rates have lower life expectancy. And there are plenty more results connecting socio-economic variables to various health problems, stating the importance of socio-economic variables in health economics. Also advocating the possible role of socio-economics for health issues such as bedtime procrastination and sleep deficiency.

Kroese et al. (2016) state three different criteria to determine procrastination. Firstly, it is an act of delaying your intended time schedule. This includes initiating and doing new or extra activities and delaying your bedtime significantly. Secondly, there is no valid reason for the delay. This criteria excludes necessary or unseen circumstances that need to be acted on immediately. Finally, it has to be foreseeable being worse off. This insinuates that the trade-off of doing the extra activity is not in the individual's favour. When these three criteria are met, it is regarded as procrastination behaviour. Although there has been a recent surge in interest in bedtime procrastination, it is still a new field of interest for behavioural research. Hence, the number of papers connecting socio-economic factors to bedtime procrastination are limited. One paper that did take a look at the relationship between socio-economic factors and bedtime procrastination was that of Herzog-Krzywoszanska and Krzywoszanski (2019). In their research under the polish population they found unemployed and students to have a higher bedtime procrastination score compared to employed individuals.

The relationship between each socio-economic variable and sleep deficiency is expressed differently. The circumstances of a location where the individual might live has an influence on sleep quality. Hale et al. (2010) report that individuals in noisy, crime-ridden and dirty areas experience lower sleep quality. More concrete differences are found by Grandner et al. (2012) in which they found a low but significant difference in sleep quality between different states in America. Indicating neighbourhood density and location to have a significant impact on sleep quality. However, the size and difference of geographics in America might not relate to a smaller area like the Netherlands and its population as is used for this paper. When looking at education, individuals who completed college show higher

reported sleep duration compared to individuals who did not complete college (Whinnery, 2014). In their adjusted model they show that individuals of a lower education level were twice as likely to report low amounts of sleep compared to college graduates. Grandner (2014) found equal results and concluded that individuals who completed college reported less sleep disturbances and lower amounts of sleep were found by lower educated individuals. However, individuals of higher education show more sleepiness during the day which is a symptom of sleep deficiency. Grandner (2010) and Whinnery et al. (2014) both come to the conclusion that income below the level of $75000 results in more sleep complaints and less amount of sleep. Grandner (2010) adds that unemployed individuals also show lower sleep quality and sleep duration than individuals who are employed. It also displays lower sleep quality and sleep duration for individuals who are unable to work and individuals who are labelled as "homemakers". This latter finding for homemakers is however due to other physical circumstances beyond income. When looking at employment status, Grandner et al. (2010) find an increased probability of sleep complaints and less qualitative sleep for individuals who are unemployed. The duration of unemployment does not seem to have an effect on sleep.

The relationship between bedtime procrastination and sleep deficiency is very intuitive. Kroese et al. (2014) found that bedtime procrastination was related to insufficient sleep. This is also found by Herzog-Krzywoszanska and Krzywoszanski (2019), who found that their bedtime procrastination scores negatively correlated with sleep length and positively with experiencing signs of sleep deficiency. Which confirms the intuitive concept that carrying out bedtime procrastination behaviour results in delaying sleep, having less hours of sleep and therefore sleep deficiency.

The rise and threat of sleep disorders and sleep problems has now been acknowledged as a national health issue by the CDC, Centers for Disease Control and Prevention, and gained some serious attention (Sleep and sleep disorders, n.d.). However, no effective or concrete ways have been found to deal with this global health issue. Rand (2016) suggests recommendations on three different levels. They recommend individuals using set sleep timers. Employers recognize the importance of sufficient sleep and creating a fitting work environment. And finally public authorities supporting health professionals to aid individuals as well as campaign for employing changes and educational changes for instance. Therefore, it is important to get a clearer picture which subgroup of the population is vulnerable and affected most in order to allocate the help efficiently and gain maximum benefit from the efforts and existence of prevention or aid campaigns.

The next section will discuss the data selection and its content. Hypotheses will be composed and explained why these approach the main question. Subsequently, an analysis plan will be discussed to answer these hypotheses as well as their relation to the main question. Then, the analysis will be performed in the results section in order to answer the hypotheses. These hypotheses will thereafter be tied together in de discussion to answer the main question. Combined with future research recommendations and limitations.

Data & Methodology

"In this paper we make use of data of the LISS (Longitudinal Internet studies for the Social Sciences) panel administered by CentERdata (Tilburg University, The Netherlands). The LISS panel data was collected by CentERdata (Tilburg University, The Netherlands) through its MESS project funded by the Netherlands Organization for Scientific Research. The LISS panel is a representative sample of Dutch individuals who participate in monthly Internet surveys. The panel is based on a true probability sample of households drawn from the population register. Households that could not otherwise participate are provided with a computer and internet connection. A longitudinal survey is fielded in the panel every year, covering a large variety of domains including health, work, education, income, housing, time use, political views, values and personalities. More information about the LISS panel can be found at: www.lissdata.nl" (LISS Data Panel). The data used was collected by Kroese, Adriaanse, Evers and De Ridder (2016). For their research a survey was conducted about self-control, bedtime procrastination and overall sleep to give insight on bedtime procrastination and its relation to self-control and sleep deficiency. The research consisted of two separate parts. A singular questionnaire as well as a sleep diary kept by its participants. Only the data from the singular questionnaire of the survey will be used in this paper, not taking into account the second part which was recording a diary about these variables. People who work night shifts and those who received medical or mental treatment for sleep problems were omitted from the data resulting in a dataset of 2633 individuals. These individuals were omitted since working night shifts or known sleeping problems might have particular impact on their data and overal sleep deficiency. Finally, the general demographics and socio-economic variables will be added to the data by connecting the id's of its participants with the same id's in the demographics database.

Bedtime procrastination will be measured by using a section of the survey of nine questions on a 5-point scale (Appendix A). These questions are mostly about going to bed

on time and quitting activities when approaching bedtime. The nine questions also include some reverse coded questions. These scores will be combined to form an average bedtime procrastination score. Where a higher average bedtime score indicates that the individual participates more in bedtime procrastination behaviour. Sleep deficiency will be measured by two questions of the survey on a 5-point scale (Appendix B). These two questions are based on experiencing the aftereffects of sleep deficiency. Since sufficient sleep is difficult to measure for individuals, the self observed aftereffect of insufficient sleep is the closest to the true value. These scores will thereafter be combined to determine an average sleep deficiency score. Where a higher score indicates that an individual has insufficient sleep more often and experiences the aftereffects of this more often as well.

A selection of socio-economic factors is chosen to estimate a mediating effect for bedtime procrastination in the relation of these socio-economic factors on sleep deficiency. These are selected based on earlier literature on socio-economic status connecting these variables to sleep deficiency, symptoms of sleep deficiency or low amounts of sleep by Ostrove & Adler (1999) and Kaplan & Keil (1993). They selected six base variables of interest, namely: income, education, occupation, neighbourhood density, income inequality and materialistic options. The dataset did not provide data for income inequality and materialistic options for an individual leaving four main socio-economic variables of interest. These variables and the way it will be measured are the following:

Education: Education will be measured as an ordinal variable with six CBS-outcomes based on the individual's highest obtained diploma. These outcomes will then be used as a categorical variable in the regression. The possible outcomes are: Basis, VMBO, Havo/VWO, MBO, HBO, WO.

Income: The income after taxes will be used to measure the variable income as an ordinal variable. These numbers will be closest to the amount someone is able to spend. These are thereafter divided into categories and used as a categorical variable with the following possible outcomes (in euros): less than 500, 501-1000, 1001-1500, 1501-2000, 2001-2500, 2501-3000, 3001-3500, 3501-4000, 4001-4500, 4501-5000, 5001-7500 and over 7500.

Occupation: Occupation was measured by the employment status of an individual. Making it a binary variable with two possible outcomes. The status employed was given to paid employees, working for family business and self employed individuals. Unemployed status was given to individuals who were looking for a job, who were too young to work, students, taking care of the housekeeping and individuals who perform voluntary work. The decision

for this status was based on the structure and mental pressure that comes with being employed or not.

Neighbourhood density: Neighbourhood density is measured as an ordinal variable with five possible levels based on addresses per square kilometer. Individuals were divided into five different levels and thereafter used as categorical outcomes. The possible outcomes are: not-urban (>500), slightly urban (500-1000), moderately urban (1000-1500), very urban (1500-2500) and extremely urban (>2500).

A descriptive summary and an overview of the statistics of these socio-economic variables and its relation to bedtime procrastination and sleep deficiency are displayed in Table 1 and table 2.

Table 1: Descriptive summary

	Count	Mean	Standard deviation	Min	Max
Average bedtime procrastination	2633	2.751	0.844	1	5
Average sleep deficiency	2633	2.049	1.817	0	7
Education	2621	3.452	1.528	1	6
Income	2574	3.105	2.089	0	12
Occupation	2631	0.494	0.500	0	1
Neighbourhood density	2623	2.978	1.260	1	5

Table 2: Summary statistics regression socio-economic variables on average bedtime procrastination and average sleep deficiency

	Average bedtime procrastination	Average sleep deficiency
Education	0.036**	0.062*
	(0.012)	(0.026)
Income	-0.026**	-0.094***
	(0.009)	(0.019)
Occupation	0.099**	0.271***
	(0.036)	(0.076)
Neighbourhood density	0.044***	0.122***
	(0.013)	(0.028)
Constant	2.527***	1.627***
	(0.056)	(0.119)
N	2556	2556
adj. R^2	0.012	0.018

Standard errors in parentheses
$^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

With these socio-economic variables as independent variables, bedtime procrastination as mediator and sleep deficiency as dependent variable, a mediation analysis will be performed to determine the role of bedtime procrastination in the relationship between the independent and dependent variable. The remaining socio-economic not used as the independent variable will act as covariates in order to give a more accurate and complete outcome. An overview of these relations are displayed in figure 1 below.

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Figure 1: Overview mediation analysis
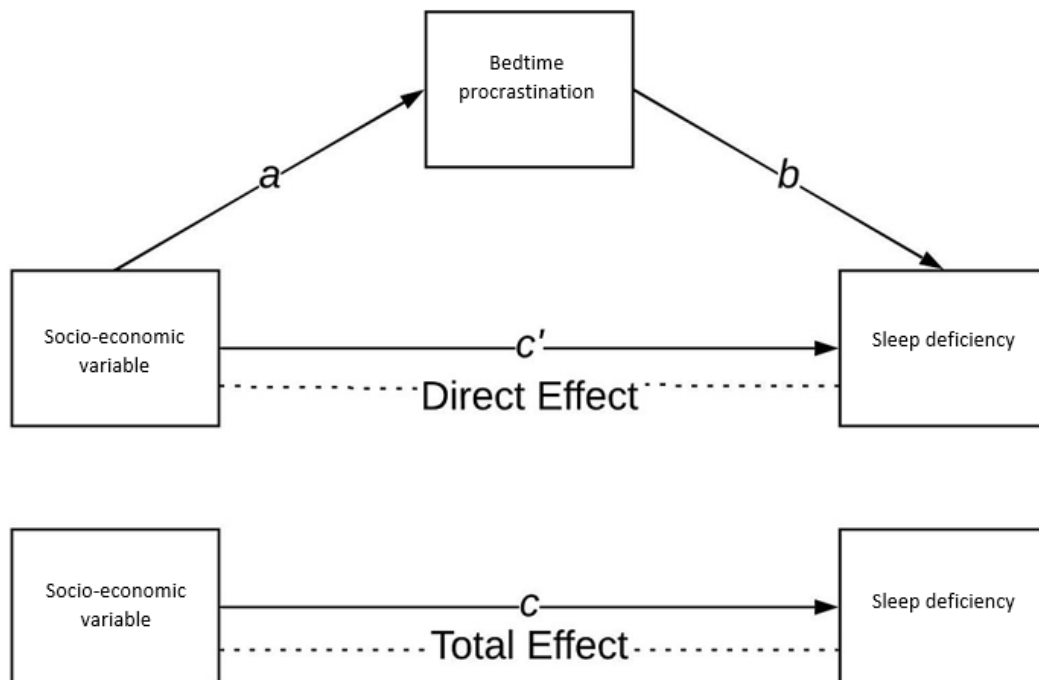
A mediation analysis consists of three different measured effects. The total effect (c) which represents the full impact of a socio-economic independent variable on the dependent variable sleep deficiency. The indirect effect (ab) which represents the impact of a socio-economic independent variable on the dependent variable sleep deficiency through the mediator bedtime procrastination. And the direct effect (c') which represents the other impact of a socio-economic variable on sleep deficiency but not through our chosen mediator. Hence, the indirect effect (ab) and the direct effect (c') combined are equal to the total effect (c). Which in summary gives the equation: ab + c' = c. With this information as output of the mediation analysis, it will be possible to determine what the indirect effect is through our mediator as well as the percentage of the total effect of an independent variable and the dependent variable that goes through bedtime procrastination. A higher percentage describes a more important role for the mediator in the relationship between the independent variable and the dependent variable.

Before analyzing the role as mediator for bedtime procrastination, four criteria must be met (MacKinnon et al., 2007). The first criteria is a significant total effect between the socio-economic variable and sleep deficiency. Secondly, a significant relation between the socio-economic variable and bedtime procrastination must be present. Thirdly, there must be a significant relation between the mediator bedtime procrastination and sleep deficiency when both the socio-economic variables and bedtime procrastination are used as predictors

for sleep deficiency. And finally, the total effect should be larger than the direct effect. Only when these four criteria are met, can bedtime procrastination be considered a mediator for that particular socio-economic variable. Therefore, the first four hypotheses will contribute to answering these four relationships and validating a possible role as mediator when all are statistically significant.

Hypothesis 1: The socio-economic variable is significantly related to sleep deficiency.

Hypothesis 2: The socio economic variable is significantly related to bedtime procrastination.

Hypothesis 3: Bedtime procrastination is significantly related to sleep deficiency when both the socio-economic variable and bedtime procrastination are used as predictors.

Hypothesis 4: The total effect is larger than the direct effect.

Thereafter, when all four hypotheses show a positive result, the role as mediator for bedtime procrastination will be measured as indirect effect as well as percentage mediation for each socio-economic variable. Hence, the third hypothesis is:

Hypothesis 5: Bedtime procrastination plays a significant role as mediator in the relation between socio-economic variables and sleep deficiency.

With these results regarding the effects between the three variables, it will be possible to describe the relation between socio-economic variables, bedtime procrastination and sleep deficiency. These results will help analyze and answer the main question: *Does socio-economic status influence bedtime procrastination mediated sleep deficiency?* And determine who and where the vulnerable and/or most affected individuals are and which subgroup would benefit most from aid or intervention regarding bedtime procrastination.

Results

Firstly, the coherence of the questionnaire used to determine a score for bedtime procrastination and sleep deficiency is verified. This is done by calculating a cronbach's alpha for both variables. This cronbach's alpha when a set of questions is regarded as coherent and viable is different for some researchers. However, most are in agreement that values above the threshold of 0.7 are sufficient. The Cronbach's alpha for bedtime procrastination, as displayed in figure 2, is 0.88, which lies far above the normally accepted

threshold of 0.7. The Cronbach's alpha for the sleep deficiency questions, as displayed in figure 3, is 0.72, which lies just above the threshold of 0.7 as well.

Figure 2: Cronbach's alpha bedtime procrastination

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Test scale = mean(unstandardized items)
Average interitem covariance:      .6281328
Number of items in the scale:             9
Scale reliability coefficient:       0.8818
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Figure 3: Cronbach's alpha sleep deficiency

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Test scale = mean(unstandardized items)
Average interitem covariance:     2.375357
Number of items in the scale:            2
Scale reliability coefficient:       0.7191
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Following, a mediation analysis was performed for each one of the four socio-economic variables individually with the other socio-economic variables used as covariates. This mediation analysis will calculate coefficients for each of the relations described in Figure 1. These mediation results and its statistical significance are displayed in Table 3.

Table 3: Mediation analysis results socio-economic variables on sleep deficiency through bedtime procrastination.

	Education	Income	Occupation	Neighbourhood density
a	0.036**	-0.026**	0.099**	0.044**
	(0.012)	(0.009)	(0.035)	(0.013)
b	0.902**	0.902**	0.902**	0.902**
	(0.038)	(0.038)	(0.038)	(0.038)
c (total effect)	0.062*	-0.094**	0.271**	0.122**
	(0.026)	(0.019)	(0.076)	(0.028)
c'(direct effect)	0.030	-0.070**	0.181**	0.082**
	(0.023)	(0.017)	(0.069)	(0.026)
ab (indirect effect)	0.033**	-0.024**	0.090**	0.040**
	(0.011)	(0.008)	(0.032)	(0.012)
Mediation Percentage	0.523	0.252	0.331	0.325
N	2556	2556	2556	2556

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$

Hypothesis 1 questioned the significant relation between a socio-economic variable and sleep deficiency, which is represented by path c in Table 3. The relation between a socio-economic variable and sleep deficiency show a statistical significant result for all four socio-economic variables of interest. With significance on a 1% level for income, occupation and neighbourhood density and a significance on a 5% level for eduation. The second hypothesis researched whether the relationship between a socio-economic variable and bedtime procrastination show a statistical significant relation, which is represented by path a in Table 3. A statistical significant relation is again found for all four socio-economic variables of interest. The third hypothesis questioned whether bedtime procrastination is statistically significant related to sleep deficiency when both the socio-economic variable and bedtime procrastination are used as predictors. This is evaluated by looking at path b in Table 3. Since this relation is drawn from the same population for each variable, it results in the same statistical significant result for each socio-economic variable. Meeting the third criteria. The final criteria was a larger total effect than direct effect. This is done by comparing total effect path c with direct effect path c' in Table 3. This criteria is met by all four socio-economic variables. Hence, all socio-economic variables meet the four criteria in order to review the fifth hypothesis and analyze a possible role as mediator for bedtime procrastination.

To answer the fifth hypothesis and determine the role of bedtime procrastination as mediator in the relation between socio-economic variables and sleep deficiency, a mediation analysis was performed for each individual socio-economic variable. Education shows a positive and significant total effect on sleep deficiency. This means a higher educational background results in higher reported average sleep deficiency. When introducing bedtime procrastination as a mediator, education also shows a positive and significant effect on bedtime procrastination. This indicates higher completed education leads to a higher average engagement in bedtime procrastination behaviour. Which together with the significant relation between bedtime procrastination and sleep deficiency result in a positive and significant indirect effect. Hence, the mediator bedtime procrastination plays a significant role in the relation between education and sleep deficiency. Besides this positive indirect effect after introducing bedtime procrastination as a mediator, the direct effect, which represents the rest of the change in sleep deficiency due to education, is shown to have no significant role anymore. Making it a full mediation. When analysing the mediation percentage for education, a score of 0.523 is given. Thus, 52,3% of the total effect is mediated by bedtime procrastination. Emphasizing the importance of bedtime procrastination in the relation between education and sleep deficiency.

When taking a closer look at the mediation analysis of income, a negative statistical significant relation is found for income and bedtime procrastination as well as for income and sleep deficiency. Hence, a higher income leads to a lower score for average bedtime procrastination and average sleep deficiency. When introducing bedtime procrastination as a mediator in the relation between income and sleep deficiency, a negative and statistical significant indirect effect is found. Explaining a statistical significant influence for bedtime procrastination as mediator with roughly 25% of the change in sleep deficiency due to income is mediated through bedtime procrastination. Unlike for education, the direct effect still shows statistical significance, making it a partial mediation.

For occupation, just like for income, a partial mediation was found. A significant relation of 0.099 between occupation and bedtime procrastination was found as well as a significant total effect of 0.271 between occupation and sleep deficiency. Which explains individuals with paid employment, report a higher average bedtime procrastination score and average sleep deficiency score than individuals who study, do voluntary work or who are unemployed. Combined with the effect of bedtime procrastination on sleep deficiency which is 0.902 for this subset, an indirect effect of 0.090 is found for the relation of occupation on sleep deficiency through bedtime procrastination. When analysing the mediation percentage, a score of 0.331 is found. Which explains that nearly a third of the total effect of occupation on sleep deficiency is mediated through bedtime procrastination.

Finally for neighbourhood density, a partial mediation is found. The measured total effect between neighbourhood density and sleep deficiency is 0.122 and significant. Thus, individuals living in an area with more addresses per square kilometer report a higher average sleep deficiency score. This also applies to bedtime procrastination, with a score of 0.044. With a significant effect of 0.902 between bedtime procrastination and sleep deficiency, a significant indirect effect of 0.040 is found for the relation between neighbourhood density and sleep deficiency through bedtime procrastination. The direct effect between neighbourhood density and sleep deficiency is still significant. Resulting in a partial mediation for bedtime procrastination. Nevertheless, with a mediation percentage of 0.325, roughly a third of the difference between neighbourhood density and sleep deficiency is mediated through bedtime procrastination. Representing a significant part of the total effect between the two.

Discussion

With recent attention and knowledge about sleep and sleep deficiency, the Centers for Disease Control and Prevention acknowledged sleep disorders and insufficient sleep as a national health issue (Sleep and sleep disorders, n.d.). Accompanied with its impactful individual health risks as well as societal effects (Chattu et al., 2019). Bedtime procrastination behaviour by individuals was found to be strongly related to sleep deficiency (Kroese et al., 2014). Which resulted in a rise of interventions and campaigns regarding bedtime procrastination. Since this is a recent field of interest, the literature about prevalence and severity of bedtime procrastination among certain subgroups is scarce. Hence, this paper tries to contribute to this by analyzing the role of bedtime procrastination as mediator in the relationship between certain socio-economic variables and sleep deficiency. Following Ostrove & Adler (1999), four socio-economic variables of interest were selected. Namely, education, income, occupation and neighbourhood density. The role of bedtime procrastination as mediator in the relationship between these four socio-economic variables and sleep deficiency was analyzed by setting five hypotheses, followed by performing a mediation analysis. All four socio-economic variables, education, income, occupation and neighbourhood density showed a significant relation with bedtime procrastination and sleep deficiency. Thereafter, the role for bedtime procrastination as mediator was analyzed for socio-economic variables of interest. Partial mediation was found for income, occupation and neighbourhood density where the direct effect remained significant. And a full mediation was found for education. Hence, the direct effect was no longer significant, emphasizing the important role for bedtime procrastination in the relationship between socio-economic variables and sleep deficiency.

The main purpose of this paper was answering the main question: *Does socio-economic status influence bedtime procrastination mediated sleep deficiency?* When analyzing the results of the mediation analysis, education, occupation and neighbourhood density all show a statistical significant positive relation with bedtime procrastination and sleep deficiency. Hence, a higher tier for these socio-economic variables which are related to a higher socio-economic status, results in higher reported bedtime procrastination and sleep deficiency. However, for income the opposite was occurent. A higher income tier which represents a higher socio-economic status resulted in lower reported average bedtime procrastination and sleep deficiency. When looking at previous research, a higher reported sleep deficiency due to higher education is in line with the results of Grandner (2014). However it contradicts the findings of Whinnery et al. (2014), who found that lower educated individuals reported less overal sleep. Grandner (2010) and Whinnery et al. (2014) both

found that lower income would lead to higher reports of sleep deficiency for which similar results were found in this paper. The results for neighbourhood density were also in line with previous research, where a more crowded, noisy and dirty neighbourhood would lead to lower sleep quality and therefore higher reported sleep deficiency (Hale et al., 2010). However, for occupation the opposite of previous research was found. Unlike Grandner (2010) and Herzog-Krzywoszanska and Krzywoszanski (2019), who found unemployed to report greater sleep deficiency and take part in bedtime procrastination behaviour, this paper found the oppsite result. Where paid employed individuals reported higher average bedtime procrastination and sleep deficiency scores. The largest mediation percentage, which represents the role for bedtime procrastination as mediator, was found for education. Altogether, a significant role in the relationship between socio-economic variables and sleep deficiency was found.

With the rise of aid programs and campaigns, a second complementary aim of this paper was to find the most affected and vulnerable subgroups of society. Targeting all individuals would be too demanding and expensive. Hence, mapping subgroups could contribute to efficiently allocating the aid programs and campaigns to the people who would benefit from it most and maximizing the impact per dollar of an initiative. Earlier mentioned recommendations by Rand (2016) advised the important role of employers, which is also found in this paper. Paid employees show higher scores for bedtime procrastination and sleep deficiency and could benefit more from aid. This also applies to their third recommendation which focuses on educational institutions. Significantly higher scores are reported for individuals who are higher educated. Hence, a campaign at higher educational institutions could affect these more vulnerable individuals. Rand states both educational institutions and employers could contribute by creating a better working/education schedule and environment which fits individuals schedules better. Which could in turn result in lower bedtime procrastination and therefore lower sleep deficiency.

A point of caution are the results of income in this dataset. In the questionnaire individuals had the option to not reveal their income, which in turn resulted in either a missing value or a result which was added to the no income group. Therefore, the results of income could be slightly skewed and give incorrect results. As well as the income being categorized in 13 levels, where a lineair regression coeffecient was assumed for each tier difference. Which in reality is unlikely. Also sleep deficiency was determined from a 2-question scale regarding self-observed behaviour, which in turn could lead to different results as these signs are often ignored by individuals (sleep deprivation and deficiency, n.d.). Another point of concern, is the low R^2 for these socio-economic variables regarding bedtime procrastination

and sleep deficiency as displayed in Table 2. Only making these socio-economic variables responsible for a small but however statistical significant amount of change in either bedtime procrastination or sleep deficiency. Finally, these results show the significance of bedtime procrastination for socio-economic variables, but it approaches these results on a basic lineair level. Future research can be done in order to take a closer look at a certain socio-economic area of interest. For instance, dividing occupation by job characteristics instead of comparing employed to unemployed. And as mentioned before, a complete and correct set of income could give a definitive result on its relation with bedtime procrastination and sleep deficiency.

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Appendix

Appendix A. Questionnaire bedtime procrastination

1. It happens that I lie in bed later than I had intended.
2. If I have to get up early, I make sure I go to bed on time.
3. When it is time to turn off the lights, I do so immediately.
4. When it is time to go to bed, I often am still doing other things.
5. I easily get distracted by other things when I actually had wanted to go to bed.
6. In my opinion, I do not lie in bed on time.
7. I have a fixed bedtime to which I keep.
8. I want to go to bed on time, but I cannot do it.
9. In the evening, I can easily stop doing other activities to go to bed.

Appendix B. Questionnaire sleep deficiency

1. In a regular week, how often do you have the feeling of not having slept enough?
2. In a regular week, how often do you feel tired during the day?