Erasmus University Rotterdam
Erasmus School of Economics

The association between risky health behaviors and bedtime procrastination, evidence from young adults in the Netherlands

Mohamed Orban, 525758
Supervisor: Lisa Voois
Second assessor: David Gonzalez Jiminez
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Abstract

Bedtime procrastination, the phenomenon of delaying going to bed when it is within an individual's benefit to go to bed instead, is shown to be positively correlated with insufficient sleep in the general population. This research aims to expand on the growing field of literature on bedtime procrastination by examining its association with risky health behaviors among young adults in the Netherlands. The focus is on the frequency of consumption of risky substances, namely alcohol, tobacco, marijuana/hashish, and schedule 1 drugs. With the understanding that bedtime procrastination is a self-regulation phenomenon, this association is explored through controlling for innate personality traits that capture the potential mediating relationship of self-regulation and impulsivity in this association. In a sample residing in the Netherlands between the ages of 18-28 (N=74), we find a significant association between the frequency of marijuana use and the degree of bedtime procrastination. We also examine the heterogeneity by gender and ethnicity in the partial association between the risky health substances and bedtime procrastination. We cannot conclude that there is a significant difference between males and females in the relationship between risky health behaviors and bedtime procrastination. Additionally, we cannot conclude a significant heterogeneity in the association risky behavior and bedtime procrastination for Dutch vs. Non-Dutch individuals in the sample.

Table of Contents

INTRODUCTION 4

DATA 9

METHODOLOGY 14

DISCUSSION AND CONCLUSION 21

REFERENCES 24

APPENDIX A 28

Introduction

Understanding the potential consequences of common risky health behaviours is essential for promoting a healthy lifestyle. One study finds that in a representative sample of adults in In the Netherlands, around half of the sample exhibited at least two of the following behaviors: smoking, unhealthy nutrition, alcohol use, and insufficient physical activity (Dieteren et al, 2020). Additionally, 7 percent of 15–35-year-olds in the Netherlands report using Methylenedioxymethamphetamine (MDMA/ecstacy) while 4 percent report using cocaine, indicating that drug use in the Netherlands is prevalent among young adults (EMDC, 2019). The prevalence of marijuana consumption in the Dutch population is also evident, as possession is decriminalized in small quantities since 1976 and therefore consumption is de facto legalized (MacCoun et al., 2009).

The adverse health effects of such behaviors are apparent in the everyday functioning of individuals. Notably, the impact of unhealthy behaviors on one's quality of sleep are thoroughly documented in the literature. It is reported that cigarette smokers are significantly more likely to report disruptions in going to sleep, staying asleep, as well as daytime sleepiness (Phillips et al., 1995). Additionally, smoking increases the likelihood of sleep apneas and is associated with shorter sleeping hours and lower sleep efficiency, which is the ratio of total sleep time to time in bed (Jaehne et al., 2012). Studies that attempt to uncover the effect of alcohol on sleep indicate that it is generally adverse, as rapid eye movement (REM) sleep is significantly disrupted after high doses of alcohol while slow wave sleep (SWS) increases, causing an overall decrease in sleep efficiency (Ebrahim et al., 2013). Furthermore, in a sample of college students who consume marijuana regularly, it was found that using marijuana to sleep is linked to problematic use, worse sleep efficiency, and daytime disfunction (Drazdowski et al., 2018). Moreover, stimulant drugs such as Methylenedioxymethamphetamine (MDMA) and cocaine have been found to damage brain serotonin, which is an important modulator of circadian rhythms and sleep, causing a significant increase in sleep disruption (McCann et al., 2007). This suggests that the act of consuming such products may impact the physical and psychological processes that are essential for sleep to occur.

The pursuit of sufficient sleep is an imperative health behavior that may not be encouraged enough in the daily lives of individuals. One study finds, through a natural

experiment that provides strong evidence for causality, on a sample of high school students that a one hour increase in sleep duration can lead to a 4.2% decrease in the risk of being overweight (Do et al., 2019). Furthermore, the findings of a randomized controlled trial suggest that insomnia causes an increased occurrence of psychotic experiences and mental health issues (Freeman et al., 2017). Poor sleep quality is also strongly associated with poverty and the consequences of not getting sufficient sleep range from short term associations with increased fatigue, memory problems, and stress (Ram et al, 2010), to potential long term health consequences related to circadian rhythm disruptions such as greater risk for cardiovascular disease, type 2 diabetes, obesity, and cancer (Kopasz et al. 2010). The potential economic consequences of insufficient sleep are also worth noting, as the decrease in the marginal returns to effort can translate to significant decreases in economic parameters such as per capita income (Kopasz et al. 2010). Nevertheless, an analysis of the procedure of going to bed is necessary given the fact that the vast majority of literature focuses on external factors outside of the process that may affect the sleeping hours.

An important initiative individuals take in order to sleep is going to their bedroom and lying in bed since it is an indication that the person intends to sleep. Naturally, going to bed is generally considered an unavoidable action; a matter of ‘’when’’ rather than ‘’if’’ they go to bed. Often, individuals tell themselves that they would like to go to bed at a certain time for future-related purposes, yet they choose to go to bed later because they prefer doing something else other than going to bed when their desired bedtime approaches. This phenomenon is referred to as bedtime procrastination (Kroese et al., 2016). It would therefore be interesting to understand whether the practice of risky health behaviors can affect the process of going to sleep by affecting the initial intention to go to sleep, since it provides further clarification on the potential causes of insufficient sleep in the population.

From a theoretical perspective, bedtime procrastination can be understood as a sub-category of the phenomenon of general task procrastination since it is essentially an act of avoidance towards a certain goal in favor of short-term rewards. This is empirically reaffirmed as well, since people who tend to procrastinate on their individual tasks/goals are more likely to go to bed later than intended (Kroese et al. 2014). Therefore,

Procrastination is considered to be a self-regulation/self-control problem, which is defined as the ability to restrain oneself from needless desires or impulses in order to achieve an overarching goal (Senecal et. al, 2010). It is also an example of time-inconsistent behaviour, as it is a preference to voluntarily delay an intended action or task in which the benefits would not be realized immediately in order to achieve a less beneficial goal that will be immediately fulfilled. Such preferences are referred to as present-biased preferences, since individuals tend to pursue immediate gratification over utilities realized in the future (Rabin et. al, 2001). This is considered as irrational behaviour due to the decrease in total utility that occurs by ignoring one's future utility. For example, a person may find themselves ignoring the significant benefits of going to bed on time in favor of focusing on the instant benefit of watching another episode of their favorite television series.

A person's harmony with their self-control is innately different across individuals as individuals can have poor self-regulation due to the differences in their inherent personality traits and cognitive functioning (Luszczynska et al., 2004). That being said, Low self-regulation is associated with more engagement in risky health behavior, including the consumption of risky health substances such as alcohol, tobacco, marijuana, or hard drugs (De Ridder et al., 2006; Dvorak et al., 2014; Miller et al., 2011). This suggests a potential confounding role of self-regulation in the relationship between risky behaviors and bedtime procrastination. In addition, impulsivity, or the tendency to act with little or no forethought, can be considered a form of self-control failure when considering impulsive actions that are not aligned with the individual's ideal standards.

Nonetheless, controlling for self-regulation and impulsivity in the correlation between risky health behaviors on bedtime procrastination takes away from the potentially mediating effect that an individual's short-term self-control has in this relationship. The phenomenon of self-regulation can also incur short-term manipulations within an individual, as it can behave as a limited resource or 'muscle' that can be depleted through its activity (Muraven et al., 1998). An individual's self-control is generally weaker at night, making the decision of going to bed more difficult to take (Baumeister, 2002). This conceptualization of self-control implies that it must be allocated in a way that is most beneficial so that it does not deplete at a critical time. individuals may deplete a

great deal of their self-control after consuming alcohol or other drugs, also the addictive nature of certain risky health behaviours such as smoking, and cocaine use can have consequences on one's self-control (Walters et. al, 2018). A core criterion of substance addiction is an inherent loss of self-control towards consuming the related substance (Weinberg et al., 2013). Alcohol consumption is shown to promote self-control failure through addiction as well as reducing self-awareness (Steele et al., 1985). This suggests that a person who engages in such behaviors must use a significant amount of their self-control capacity to regulate their behaviour, and thus potentially causing self-regulation failure in other actions that require the engagement of self-regulation. Consequently, there is a potential relationship between alcohol and bedtime procrastination through self-control as a mediator. Additionally, short term changes in impulsive behavior is also a potential mediator for the relationship between risky health behaviours and bedtime procrastination (Reed et. al, 2012).

While none of the sleep-related research establishes this relationship, the literature does note that smoking, alcohol, marijuana, and poor physical health are significantly associated with general procrastination across different samples (Day et al., 2013; Hannah Lee et al., 2021; Sirois et al., 2003; Van Roon, 2018), as well as a significant positive association between bedtime procrastination and general procrastination (Kroese et al. 2014). Thus, this research aims to establish a link between risky health behaviours and the intention of going to bed at a certain time by investigating the following risky behaviours: alcohol consumption, smoking, marijuana, and drug use, and their association with bedtime procrastination for young adults. The focus of this research is on the intention of going to sleep. This means that the outcome depicts the self-reported disparity between the time a person wants to go to bed and the time they lie down on their bed.

This novelty adds onto the procrastination literature by further emphasising possible behaviours that may potentially perpetuate an individual's avoidance of goal-oriented actions that are necessary for optimal health behaviour. This association expands upon the potential causes of bedtime procrastination and the additional implications of suboptimal consumption habits. It is also imperative to contribute to the literature related to insufficient sleep for people who do not have sleep-related illnesses

or syndromes in order to tackle the problem with all its complexity. This can potentially encourage research on causal links that enhance the understanding of bedtime procrastination as well as insufficient sleep. In the case of young adults, which is the target demographic of this research, insufficient sleep can lead to general physical and mental impairments that are common at this stage of their life and can critically interfere with their day-to-day obligations, be it academic or work-related (Owens et al., 2014). Establishing bedtime procrastination as a sleep-impairing problem that may be mitigated through decreasing engagement in risky behaviour provides an avenue through which individuals can potentially decrease their irrational behaviour and better achieve their health-related and daily goals. This would encourage institutions such as universities to raise awareness for such implications and therefore promote better health and behaviour.

The main hypothesis of this research is intended on testing whether there is a relationship between any of the aforementioned risky health behaviors and bedtime procrastination. Therefore, we aim to test whether an increase in the frequency of engagement in risky health behaviors (smoking, alcohol, marijuana, or drugs) correlates to a larger degree of bedtime procrastination on average.

After understanding the possible associations between the risky health behaviors and the degree of bedtime procrastination, we aim to understand the partial associations of risky behaviors on the participants' intention to go to bed for the subgroups that are more prone to risky behavior. The role of gender in this relationship is interesting to investigate since males engage in significantly more risky health behaviors than females (Philip et al., 2001). One study finds that around 17% of adult males smoke in the United States while 13.5% of females smoke, a difference that is shown to be significant (Jamaal et al., 2018). Furthermore, male drinkers drink on average nearly three times as much (19.0 liters) as female drinkers (6.7 liters) (White, 2020). Such disparities may be due to physiological, behavioral, or cultural differences across the genders. Additionally, males tend to procrastinate their bedtime more than females (Turkarslan et al., 2019), which raises the question of whether the partial association of risky health behaviors with bedtime procrastination is stronger for men than for women, since this analysis would help explain whether males are more likely to procrastinate going to bed due to their relatively larger consumption of risky substances. Therefore, we hypothesize that an

increase in the frequency of engagement in risky health behaviors (smoking, alcohol, marijuana, or drugs) is associated with a larger degree of bedtime procrastination on average for males.

Finally, incorporating an analysis of the effect of one's ethnicity in the Netherlands may be beneficial since in a sample of Dutch students who have a mean age of 18 years are shown to be more likely to engage in risky behaviors than non-Dutch students, as it is shown that students of Dutch ethnicity were on average 51% more likely to report using marijuana, tobacco, or alcohol (Bannink et al., 2010). Although the students in this sample attended vocational education while our focus is on university students, it implies that capturing the association between risky health behaviors and bedtime procrastination for Dutch individuals is beneficial in order to account for ethnicity. Additionally, the Netherlands is known to have a relatively liberal stance on illicit substances by focusing on harm-reduction policies rather than prosecuting users (Rigoni, 2019). Marijuana is also decriminalized for personal use in small quantities in the Netherlands (Reinarman et al., 2004). Such policies may normalize consumption among Dutch individuals and possibly lead to greater adverse effects from their availability. The association between risky health behaviors and bedtime procrastination for Dutch individuals is therefore worth analyzing through the hypothesis that an increase in the frequency of engagement in risky health behaviors (smoking, alcohol, marijuana, or schedule 1 drugs) is associated with a larger degree of bedtime procrastination on average for Dutch individuals.

Throughout this paper, we describe the approach that is taken to collect data on the variables of interest and the factors that should be controlled, as well as explain the methods of analysis that are chosen to test the significance of the associations. After understanding the sample and its characteristics, we describe and analyze the results from the chosen methods of analysis and attempt to draw conclusions on the associations given the limitations of the sample and the methods.

Data

this research aims to take an empirical self-reported approach towards understanding the link between risky health behaviour and bedtime procrastination. The method that is used to gather the relevant data is through an online survey questionnaire

developed on the Qualtrics platform (questions and format are depicted in appendix A). The survey is limited to respondents currently residing in the Netherlands in order to have the same legal framework governing the respondents. While hard drugs are illegal in the Netherlands as in most other countries, The consequences of possession and personal use are lenient compared to other countries (Government.nl, 2022). Since the young adults age group (15-35 age range) are the most prone to engaging in risky health behaviors in the Netherlands, we choose to focus on this particular demographic. Additionally, respondents with sleeping disorders and are on regular sleep-related medication are omitted from the data since such factors can affect the person's decision to go to bed outside of his/her self-control.

The survey starts with a consent form and a confidentiality statement then a set of demographic-related questions that include age, gender, level of education, and ethnicity since they are all potentially valuable controls. This is because age is found to be negatively correlated with bedtime procrastination while males tend to procrastinate their bedtime more than females on average (Krzywoszanska et al., 2019). Afterwards, a series of questions will be presented in order to determine the presence and frequency of the participants' engagement in risky health behaviors. Participants will be asked to report their frequency of using alcohol, cigarettes/electronic cigarettes/rolling tobacco, marijuana, and Schedule-1 drugs as categorized by Dutch law. Schedule 1 drugs, which are also classified as hard drugs, offer the most health risks when consumed according to the Dutch ministry of health through the Opium Act. Among other things, they include stimulants such as cocaine and amphetamines, as well as hallucinogens such as MDMA and psilocybin.

The line of questioning follows a survey from the IISS panel which includes questions about the recency and frequency of usage for each substance (Crutzen et al., 2010). We ask participants whether they have consumed the given substance within a certain period from answering the survey in order to focus on current users and directly link current usage with the desired outcome. Afterwards, they are asked how many times on average they consume the substance within a given time period. Given that they do consume the substance, participants are asked to report the average frequency of alcohol and marijuana consumption within a one-week period. The average frequency of smoking

is given by the daily average. Finally, the frequency of schedule-1 drugs is given by the monthly average other than MDMA, which is given as a three-month average due to its long-term impact on serotonin levels, anxiety, and memory (Morley et al., 2001). The value of the MDMA frequency will be divided by three and added to the frequency of schedule 1 or 'hard' drugs to give the monthly average consumption of all hard drugs.

The aim is to control for innate personality traits that are associated with self-control and impulsiveness which are not affected by risky health behaviours. The Big Five Personality Model (conscientiousness, agreeableness, openness, extraversion, and neuroticism), initially developed by D.W Flake and expanded upon over time, has been deemed as a significant predictor for self-regulation across all the traits of personality in the model (Mao et al., 2018). The traits of agreeableness (tendency for prosocial behavior), conscientiousness (thoughtfulness and tendency for good organization), extraversion (tendency to feel energized by the company of others), and openness (eagerness to experience and learn new ideas/actions) are all positively correlated with self-control and negatively correlated with impulsivity. On the other hand, neuroticism (moodiness and emotional instability) is negatively correlated with self-control and positively correlated with impulsivity. Additionally, a significant trait to take into account for this relationship is the individual's chronotype, which is the individual's natural inclination to sleep at a certain time. A person may procrastinate going to bed if he/she is more nightime-oriented (eveningness) since they would be more easily stimulated by their surroundings at night. This is also suggested in the literature since eveningness is positively correlated with general procrastination (Przepiorka et al., 2019). Nevertheless, controlling for such traits allows for an examination of the relevant associations while keeping constant the inherent personality traits that may perpetuate going to bed later than intended.

Furthermore, the big 5 personality traits will be assessed through the Ten Item Personality Measure (TIPM), which is a measure developed in order to assess the participants' personality traits quickly while not losing much reliability (Gosling et al., 2003). The TIPM is nonetheless deemed as an appropriate framework for measuring the big 5 personalities when brief measures are needed (Nunes et al., 2018). the reason for choosing a brief measure is to focus the time taken to finish the survey towards the

questions related to the independent and dependent variable in order to maximize their reliability, as well as increase the number of potential respondents with a shorter questionnaire. Moreover, the degree of bedtime procrastination will be assessed using the Bedtime Procrastination Scale (BPS), which is a 5-point scale that includes nine items to assess. A score of 1 indicates '(almost) never' and a score of 5 indicates '(almost) always' for each of the items (eg. 'I go to bed later than intended'). The scale is shown to be valid in assessing sleep outcomes in multiple literature (Kroese et al., 2014). Finally, respondents are asked a series of questions regarding their chronotype, which follows the reduced Morningness-Eveningness Questionairre (rMEQ). the questions translate to a scale between 4 and 25 and categorize the participants into one of the following groups: Evening oriented with a score of between 4 and 11, neutral with a score between 12 and 17, and morning-oriented with a score higher than 17 (Loureiro et al., 2015). The survey is then concluded, and the respondents are thanked for their contribution.

After the data is retrieved, it is analysed through the statistical program STATA. Any observations with missing responses and responses that do not meet the inclusion criteria regarding age and sleep-related disorders will be omitted from the dataset.

The survey concluded on the 15th of June, 2022, and a total of 97 participants have chosen to respond to the survey with their response being recorded. That being said, only 74 of the responses have been found to meet the inclusion criteria for the sample as well as answer all of the questions in the survey. Therefore, the sample contains 74 observations that are within the age of 18-29 years, reside in the Netherlands, and whom do not take any sleep-related medication and do not have any sleep-related disorders. The following table shows the characteristics of the sample through descriptive statistics.

Table 1: Descriptive statistics of sample, considering excluded responses

Variables	Mean	SD	Min	Max	Observations
Demographics					
Age	22.43	2.40	18	29	74
Male	0.45		0	1	74
Dutch	0.42		0	1	74
Education					
Highschool	0.04		0	1	74
Bachelor's degree	0.62		0	1	74
Master's degree	0.31		0	1	74
PHD	0.02		0	1	74
Risky health behaviors					
Alcohol	0.74		0	1	74
Alcohol frequency	4.34	6.57	0	40	74
Smoking	0.51		0	1	74
Smoking frequency	1.9	3.6	0	20	74
Marijuana	0.43		0	1	74
Marijuana frequency	4.88	9.77	0	50	74
Hard drugs	0.24		0	1	74
Hard drugs frequency	0.29	0.67	0	3	74
Personality items					
Extraversion	4.11	1.32	1	7	74
Agreeableness	4.56	0.85	2.5	7	74
Conscientiousness	4.85	1.21	1.5	7	74
Neuroticism	4.34	1.21	2	6.5	74
Openness	4.90	1.17	1.5	7	74
Chronotype					
Evening-oriented	0.32		0	1	74
Neutral	0.59		0	1	74
Morning-oriented	0.08		0	1	74
Sleep Variables					
BPS	3.38	0.86	1.11	5	74
Hours of sleep	7.32	1.09	5	10	74

Notes. This table depicts, for the sample, the number of observations, mean, standard deviation, minimum, and maximum values for all variables gathered from the survey. The variables 'alcohol frequency' and 'marijuana frequency' depict the number of times a participant consumes the respective substance on average in one week. The variable 'smoking frequency' depicts the number of times a person smokes on average per day. The variable 'hard drugs frequency' depicts the number of times a person consumes schedule-1 drugs on average per month.

We observe through the descriptive statistics that the sample has an average age of 22, a minimum age of 18, and a maximum of 29, which suggests that they consist of young adults. Furthermore, 45% of our sample is male, 42% are Dutch, and most of the sample consist of Bachelor's degree and Master's degree students/graduates. We also observe that 74% of the sample are current consumers of alcohol (have consumed

alcohol within the two weeks before answering the survey) and the average weekly consumption of alcohol is 4.3 drinks. Additionally, 51% are regular smokers (have smoked nicotine-related products in the two weeks before answering the survey) and smoke 1.9 cigarettes per day on average. 43% of the sample have consumed marijuana in the week before answering the survey and they consume on average 4.9 times. Finally, 29% have consumed schedule-1 drugs (including MDMA) in the two months before the survey (three months if consumed MDMA) and only consume 0.3 times on average per month. The outcome variable BPS has an average of 3.4 across the sample, which is greater than the median of the scale, indicating that the participants generally report that they experience the symptoms of bedtime procrastination more often than not. Additionally, it is observed that 59% of the sample is in the neutral category of chronotype, while 32% are categorized as evening-oriented, meaning in this sample participants were more likely to be evening-oriented than morning-oriented. Participants also scored out of seven on average a 4.1 for extraversion, a 4.6 for agreeableness, a 4.9 for conscientiousness and openness, and a 4.3 for neuroticism. Concerning the average hours of sleep in this sample, a mean of 7.32 is considered appropriate sleep duration for healthy young adults, which is a positive indication regarding the respondents' sleep quality.

to determine the internal consistency of the scales that are used for the BPS, we calculate the Chronbach Alpha for the items used for the BPS. A Chronbach Alpha score of between 0.7 and 0.9 indicates internally consistent results between the items. The assessment of the internal consistency of the BPS gives a Chronbach alpha of 0.71, which indicates that the items yield a good level of agreement without being redundant. This reaffirms the reliability of the scale and the responses.

Methodology

The hypotheses will be tested through a series of OLS multiple regressions using robust standard errors. The sign and the significance of the coefficient will indicate whether we can or cannot reject our null hypotheses. For the hypothesis 'H0 = No association between risky health behaviors and bedtime procrastination' the following regression will be used as a test:

$$Y_i = \alpha + \beta_1 Alcohol_i + \beta_2 Smoking_i + \beta_3 Drugs_i + \beta_4 Marijuana_i + \beta_5 Openness_i + \beta_6 Conscientiousness_i + \beta_7 Neuroticism_i + \beta_8 Agreeableness_i + \beta_9 Extraversion_i + \beta_{10} Chronotype_i + \beta_{11} Education_i + \beta_{12} Age_i + \beta_{13} Gender_i + \beta_{14} Dutch_i + \epsilon_i$$

Where Y_i is the degree of bedtime procrastination given by the BPS as a continuous variable, where a higher score corresponds to a higher degree of bedtime procrastination, and ϵ_i is the error term. The coefficients indicate the change in the degree of bedtime procrastination given a unit change in the explanatory variables. This captures the magnitude of the association and therefore no causal links can be inferred by these changes. Gender takes on the value of 1 when the respondent is male, and Dutch takes on the value of 1 when the respondent is Dutch. The coefficients of the risky behaviors depict the change in BPS due to a unit increase in average consumption over the relevant period for each substance. For example, the β_1 coefficient depicts the increase in BPS due to a person drinking one more drink of alcohol per week on average. The 95% confidence interval will determine the rejection criteria for the significance of the coefficients. The regression results are first presented without the control variables in order to understand the implications of adding them to the regression. The change in the main four coefficients due to the controls will indicate the degree and sign of bias as a result of leaving out the controls.

Secondly, for the null hypothesis 'H0= No heterogeneity by gender in the partial association between risky health behaviors and bedtime procrastination.' all the possible interaction effects between the risky health behaviors and gender will be added to the regression model as shown:

$$Y_i = \alpha + \beta_1 Alcohol_i + \beta_2 Smoking_i + \beta_3 Drugs_i + \beta_4 Marijuana_i + \beta_5 Openness_i + \beta_6 Conscientiousness_i + \beta_7 Neuroticism_i + \beta_8 Agreeableness_i + \beta_9 Extraversion_i + \beta_{10} Chronotype_i + \beta_{11} Education_i + \beta_{12} Age_i + \beta_{13} Gender_i + \beta_{14} Dutch_i + \beta_{15} Gender * Alcohol_i + \beta_{16} Gender * Smoking_i + \beta_{17} Gender * Marijuana_i + \beta_{18} Gender * Drugs_i + \epsilon_i$$

Where the coefficients of the interaction terms depict the change in BPS due to a unit increase in average consumption of each substance over the relevant period for males

compared to females. The same statistical analysis is done for the partial association of risky behavior on bedtime procrastination for Dutch individuals.

$$Y_i = \alpha + \beta_1 Alcohol_i + \beta_2 Smoking_i + \beta_3 Drugs_i + \beta_4 Marijuana_i + \beta_5 Openness_i + \beta_6 Conscientiousness_i + \beta_7 Neuroticism_i + \beta_8 Agreeableness_i + \beta_9 Extraversion_i + \beta_{10} Chronotype_i + \beta_{11} Education_i + \beta_{12} Age_i + \beta_{13} Gender_i + \beta_{14} Dutch_i + \beta_{15} Dutch * Alcohol_i + \beta_{16} Dutch * Smoking_i + \beta_{17} Dutch * Marijuana_i + \beta_{18} Dutch * Drugs_i + \epsilon_i$$

The coefficients of the risky behaviours depict the change in BPS due to a unit increase in average consumption over the relevant period for each substance for Dutch individuals.

Results

Table 2 depicts the regression results for the frequency each of the risky health behaviors on the degree of bedtime procrastination, keeping the other risky behaviors constant. The sign of the coefficients of alcohol and drug frequency are negative, which goes against the hypothesis. this could be due to the possible sedative effects that alcohol and drugs may induce which could lead to a person more likely to make the decision to go to bed (Kurdi et al., 2014), however the coefficients are not significant, possibly due to the low statistical power of the sample. That being said, we cannot conclude a significant coefficient for alcohol, smoking, or hard drugs frequency, meaning that we cannot reject that there is no association between the average frequency of alcohol, drug, or tobacco use over the respective time periods and bedtime procrastination. On the other hand, we observe a coefficient that is significant at the 1% significance level for marijuana frequency, indicating that for this sample, a one-time increase in average weekly marijuana usage increases the degree of bedtime procrastination on average by 0.04 units on average, while keeping the other substances constant. Albeit, compared to the mean of 3.5, a 0.04 change in BPS is not large, suggesting that while the change is significant, the difference may not result to a higher degree of insufficient sleep.

We compare these results to column 2 in order to assess the potential bias explained by the controls. After controlling for the relevant demographics, personality traits, and chronotype, we observe very little change in the coefficients of the risky health behaviors and their significance. The largest change in the size is from the coefficient of alcohol frequency, a change that suggests that the absence of the controls leads to a slight overestimation of the coefficient, albeit in both cases the coefficient is not significant

therefore the effect is inconclusive. Perhaps given a larger sample the size and significance of the coefficients can differ. Albeit we also cannot reject the null hypotheses that there is on average no difference in the degree of bedtime procrastination if a person smokes more, drinks more, or consumes drugs more. For marijuana use, the coefficient is still significant at the 1% significance level and has decreased only slightly after adding the controls, indicating that we can reject the null hypothesis that there is on average no difference in the degree of bedtime procrastination if a person consumes more marijuana. This suggests that the association between marijuana and self-control may translate to greater bedtime procrastination, suggesting a hinderance of bridging the gap between intention and action regarding sleep due to marijuana.

Additionally, the sign of the extraversion and agreeableness coefficient is positive while the neuroticism coefficient is negative, which is in line with the literature. The conscientiousness and openness coefficients show an opposing result to the literature albeit none of the personality traits are shown to be significantly correlated with BPS. We also observe that individuals with Dutch ethnicity procrastinate their bedtime significantly less than non-Dutch individuals. This could be due to inherent differences in culture or upbringing, since the short-term environment is similar for both groups of ethnicities because they live in the same country. Finally, we observe that males tend to procrastinate their bedtime more than females at the 10% significance level, which is noteworthy given the small sample size, that being said, the size of the difference in BPS across genders is small. The other control variables do not show a significant change in BPS.

Table 2: Regression Results for first hypothesis, with and without controls

	BPS (1)	**BPS (2)**
Constant	3.19***	3.67***
	(0.12)	(1.34)
Alcohol frequency	-0.04	-0.0013
	(0.015)	(0.015)
Smoking frequency	0.023	0.021
	(0.026)	(0.026)
Marijuana frequency	0.04***	0.039***
	(0.0099)	(0.011)
Hard drugs frequency	-0.062	-0.089
	(0.12)	(0.17)
Age		0.03

Male	0.012*
Dutch	-0.43**
Openness	-0.16
Conscientiousness	-0.015
Agreeableness	0.041
Neuroticism	-0.073
Extraversion	0.051
Chronotype	
Morning-oriented	0.10
Evening-oriented	0.19
Education	
Bachelor's degree	0.023
Master's degree	0.075
PHD	0.39
Number of observations	74

Notes. Regress y on x, where y is the self-reported degree of bedtime procrastination and x is the risky health behavior while keeping the other risky health behaviors constant in column (1), while also controlling for gender, education, ethnicity, personality traits, and chronotype in column (2). The coefficient is reported with two decimal places and the standard errors of the risky health behaviors are depicted in brackets. The significance level is depicted by the number of stars: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

The results shown in column 1 of table 3 indicate inconclusive evidence regarding the heterogeneity by gender in the partial association between risky behaviors and bedtime procrastination. The size of the coefficient is small and insignificant at the 5% significance level for all interaction effects. It should be noted that the interaction between gender and hard drugs is significant at the 10% significant level, which suggests that hard drugs is correlated with a 0.54 decrease in reported bedtime procrastination for males. This result counters the hypothesis that drugs increase the level of bedtime procrastination, possibly due to the sedative effects that certain hard drugs such as Ketamine may induce (Kurdi et al., 2014). However, given the chosen 95% confidence interval, the results suggest that we cannot reject the null hypothesis that the degree of bedtime procrastination does not differ significantly on average for males compared to females after an increase in the frequency of the engagement in risky health behaviors. This suggests that males may not be more prone to procrastinate their bedtime as a consequence of engaging in risky health behaviors more frequently.

Regarding column 2 which captures the association between the frequency of risky health behavior and bedtime procrastination for Dutch people, the results from the regression model are also inconclusive. The coefficients of the relevant interaction terms

are insignificant at the 5% significance level. The sign of the smoking interaction term with Dutch is positive while the sign of the other risky behaviors are negative. The negative coefficients may indicate that Dutch people procrastinate their bedtime less if they engage in more risky behavior however, we cannot conclude this claim. The This means that we cannot reject the null hypothesis that that the degree of bedtime procrastination does not differ significantly on average for Dutch people after an increase in the frequency of the engagement in risky health behaviors.

Table 3: heterogeneity by gender and ethnicity in the partial association of risky health behaviours and bedtime procrastination.

	BPS (1)	BPS (2)
Constant	3.58**	3.76**
	(1.51)	(1.29)
Alcohol frequency	-0.024	0.0024
	(0.029)	(0.043)
Smoking frequency	-0.0066	-0.015
	(0.072)	(0.026)
Marijuana frequency	0.039***	0.042***
	(0.011)	(0.012)
Hard drugs frequency	-0.15	-0.024
	(0.19)	(0.21)
Age	0.036	0.032
Male	0.031	-0.012
Dutch	-0.44*	-0.53*
Openness	-0.15	-0.17
Conscientiousness	-0.025	0.0046
Agreeableness	-0.034	-0.055
Neuroticism	-0.076	-0.070
Extraversion	0.063	0.072
Chronotype		
Morning-oriented	-0.019	0.0040
Evening-oriented	0.20	0.20
Education		
Bachelor's degree	0.038	-0.13
Master's degree	0.041	0.020
PHD	0.29	0.28
Smoking frequency * Male	0.025	
	(0.076)	
Alcohol frequency * Male	0.030	
	(0.031)	
Marijuana frequency * Male	-0.007	
	(0.019)	
Hard drugs frequency * Male	-0.54*	
	(0.29)	
Smoking frequency * Dutch		0.089
		(0.062)
Alcohol frequency * Dutch		-0.0052
		(0.044)
Marijuana frequency * Dutch		-0.0084
		(0.021)
Hard drugs frequency * Dutch		-0.11
		(0.37)
Number of observations	74	74

Notes. Regress y on x, where y is the self-reported degree of bedtime procrastination and x is the interaction effect between risky health behaviors and gender in column (1) and ethnicity in column (2). The controls are gender,

education, ethnicity, personality traits, and chronotype. The coefficient is reported with two decimal places and the standard errors of the risky health behaviors are depicted in brackets. The significance level is depicted by the number of stars: * p<0.1, ** p<0.05, *** p<0.01.

Discussion and conclusion

In an attempt to understand the potential associations between the risky health behaviors of alcohol, tobacco, marijuana, and schedule 1 drugs consumption and bedtime procrastination. we collected data from a sample of 74 young adults residing in the Netherlands regarding their baseline characteristics, their engagement with risky behaviors, their personality traits, and their chronotype. This aim comes from the understanding that bedtime procrastination is a form of self-regulation failure and is correlated with impulsiveness, which implies that a manipulation of one's self-regulation may result in individuals taking adverse decisions regarding going to bed. Therefore, we hypothesized an increase in the frequency of engagement in risky health behaviors (smoking, alcohol, marijuana, or drugs) is associated with a larger degree of bedtime procrastination on average. We also investigated the partial association between frequency of engagement in risky health behaviors (smoking, alcohol, marijuana, or drugs) and bedtime procrastination for males and Dutch individuals.

The results suggest that there is a positive association between increased marijuana usage and bedtime procrastination, even while controlling for the innate personality traits that correlate with self-control. We however cannot reject the null hypotheses regarding the association between tobacco, alcohol, and drug use and bedtime procrastination. In addition, we cannot reject that the partial association between risky behavior and bedtime procrastination is significant for men or for Dutch individuals.

Nonetheless, an important factor to account for is the lack of statistical power that the sample provides, as 74 observations cannot be accurately representative towards young adults in the Netherlands and the variability can be considered high when observing the standard deviations. This suggests that the null hypotheses could still be rejected given a larger sample size, which highlights that the evidence gathered with this sample is inconclusive for three of the four risky behaviors. Another limitation to the model arising from the nature of the data collection is that the sample may bring forth sample selection bias, as the results are only guided by the group of individuals that choose to

take the survey, which may be inherently different from individuals who did not have access to the survey. Additionally, the individuals who engage in risky behavior may be inherently different from the individuals who do not consume the substances by virtue of other variables that were not accounted for such as weight for example, which is highly correlated with insufficient sleep (Cooper et al., 2018).

Of course, omitted variable bias is likely to be present in this association model, as there are many factors that may affect bedtime procrastination that are not accounted for which are also correlated with risky health behaviors. An example of a possible omitted variable is if a person suffers from depressive symptoms, as depression correlates with greater bedtime procrastination as well as more engagement in risky behavior (Chung et al., 2019; Soleimani et al., 2017). Another important variable to consider is whether the individual drinks caffeine, as the half-life for caffeine in the body of an average individual is around 5 hours, which can delay tiredness until much later than one's bedtime (Institute of Medicine, 2001). Additionally, a significant factor that may cause issues with the significance and the direction of the associations is that there could be a case for reverse causality. People who tend to procrastinate their bedtime may resort to risky substances due to their sedative properties in order to fall into a state of tiredness and therefore go to bed (Kurdi et al., 2014), While the literature does not report on this association, the possibility of reverse causality in this model is noteworthy since the study of bedtime procrastination is relatively new.

A possible limitation in the data collection is that the participants were asked about their frequency of consumption of all schedule 1 drugs, which is a large category of substances that have varying effects on one's physiology or psychology. It would be more accurate to examine the potential implications of the individual drugs by grouping them by their effects (eg. Sedatives, hallucinogens, etc..) rather than grouping them by their legality according to Dutch law. Additionally, a step in enhancing the representativeness of the sample is adding more controls such as socioeconomic background, income, and relationship status. This would aid in understanding the bias of the sample towards certain groups, as well as the magnitude of the bias that such controls account for. That being said, the external validity of the associations is limited due to the chosen sample, as the high variability and the relatively small sample size implies that we can only generalize

the findings towards populations that have similar upbringings and characteristics to the collected sample. These findings may be applicable to mostly Bachelor and Master's students in the Netherlands, however more research on similar and larger samples is necessary for the representativeness of the sample to account for young adults in the Netherlands, as well as to represent the general young adult population. The associations are certainly not generalizable towards populations of other countries outside of the Netherlands.

For this reason, future research could focus on capturing a treatment effect of risky behavior on bedtime procrastination through a Randomized Controlled Trail or a natural experiment, which would have greater claims for causality rather than being purely associative. It is important to pursue the understanding of such effects to encourage methods that are more generalizable to populations outside of the Netherlands, as well as to strengthen the accuracy of the association. For example, if there is a region or country that will change its policy regarding the use of marijuana, it would be interesting to find participants from this region to keep a diary of how much they procrastinate their bedtime before the policy is implemented or during the beginning of the policy. At a certain period after the policy is taken place and its effects should be felt, the participants can also record their engagement with marijuana and their bedtime procrastination and find out the difference in bedtime procrastination before and after the policy.

All in all, the associations captured in this research regarding risky behavior and bedtime procrastination call for further investigations on such relationships. The positive correlation between marijuana and bedtime procrastination, while controlling for the relevant mediators, suggests that a possible approach towards achieving sufficient sleep for young adults is to encourage less average marijuana consumption. This is significant for a country with a liberal stance on the substance such as the Netherlands, as this could inspire further investigation on the effect of marijuana on health-related decision making. It could also incite possible informational campaigns from institutions that aim to increase the population's understanding of the effects of such products. The encouragement of sufficient sleep and health behavior starts with understanding the factors at play when a person makes important decisions, and it is with hope that this research inspires people to make healthier choices and sleep well.

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Appendix A

Start of Block: Intro/consent

Q1 Dear participant, many thanks in advance for participating in this questionnaire. This survey is intended for research that is conducted by students at the Erasmus University in Rotterdam. Answers are completely confidential, participation is voluntary, and the data collection of this survey will be anonymous. The data will only be used for research purposes.

This research is about bedtime procrastination and risky health behaviors. You will be asked about your engagement with risky health behaviors, sleep-related questions, and certain personality traits.

It approximately takes 7 minutes to complete the survey. Please answer to the best of your abilities. If you have any questions, concerns, or complaints regarding this survey please contact 525758mo@student.eur.nl.

Thank you in advance!

P.S.: This survey contains a completion code for SurveySwap.io

- ○ I state that I am voluntarily participating and agree to my responses being anonymously processed for research purposes only (1)

End of Block: Intro/consent

Start of Block: Demographics

Q1 What is your gender?

- ○ Male (1)
- ○ Female (2)
- ○ Other (3)

JS

Q2 What is your age?

_____

Q3 What is the highest level of education you have completed? If currently enrolled, choose the level you are currently enrolled for.

- ○ No schooling completed (1)
- ○ Elementary School (2)
- ○ High school (3)
- ○ Secondary vocational education (MBO) (4)
- ○ Higher vocational education (HBO) (5)
- ○ Bachelor's degree university (6)
- ○ Master's degree university (7)
- ○ PHD (8)

Q4 Where do you currently reside?

- ○ In the Netherlands (1)
- ○ Outside of the Netherlands (2)

Q44 What is your nationality?

- ○ Dutch (1)
- ○ Other (2)

End of Block: Demographics

Start of Block: Exclusion criteria/hours of sleep

Q39 Do you have any medical conditions that may affect your sleep?

- No (1)
- Yes (2)

Q40 Do you take any prescribed medication that may affect your sleep? (not including marijuana)

- No (1)
- Yes (2)

JS

Q43 How many hours of sleep per day do you get on average?

_____

End of Block: Exclusion criteria/hours of sleep

Start of Block: Risky health behavior

Q49 Have you consumed drinks containing alcohol over the past fourteen days?

- Yes (1)
- No (4)

Display This Question:

If Have you consumed drinks containing alcohol over the past fourteen days? = Yes

JS

Q1 How many drinks containing alcohol do you currently consume per week on average?

_____

Q50 Have you smoked tobacco (eg. cigarettes) or nicotine-related products (eg: e-cigarettes) over the past two weeks?

- Yes (1)
- No (2)

Display This Question:

If Have you smoked tobacco (eg. cigarettes) or nicotine-related products (eg: e-cigarettes) over the... = Yes

JS

Q10 How many cigarettes (including cigarettes from rolling tobacco or cigarillos) do you currently smoke on average per day? (If you consume tobacco from a pipe, please indicate the average amount of times you fill up your pipe per day)

_____

Q46 Have you consumed marijuana or hashish in the last fourteen days?

- Yes (1)
- No (2)

Display This Question:

If Have you consumed marijuana or hashish in the last fourteen days? = Yes

JS

Q42 How many times on average do you currently consume marijuana or hashish in the span of one week?

_____

Q47 Have you consumed MDMA or ecstacy in the last three months?

- Yes (1)
- No (2)

Display This Question:

If Have you consumed MDMA or ecstacy in the last three months? = Yes

JS

Q11 How many times on average do you currently consume MDMA or ecstacy over the span of three months?

_____

Q45 Have you consumed hard drugs (eg. cocaine, LSD, Ketamine, Speed) over the last two months?

- Yes (1)
- No (2)

Display This Question:

If Have you consumed hard drugs (eg. cocaine, LSD, Ketamine, Speed) over the last two months? = Yes

JS

Q48 How many times on average do you currently consume hard drugs (eg. cocaine, LSD, Ketamine, Speed) over the span of one month?

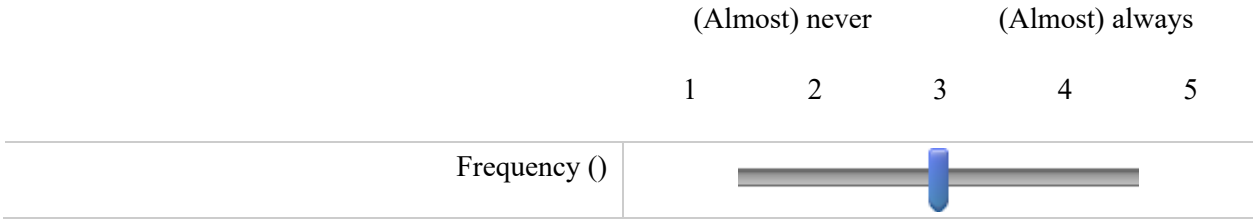
_____

End of Block: Risky health behavior

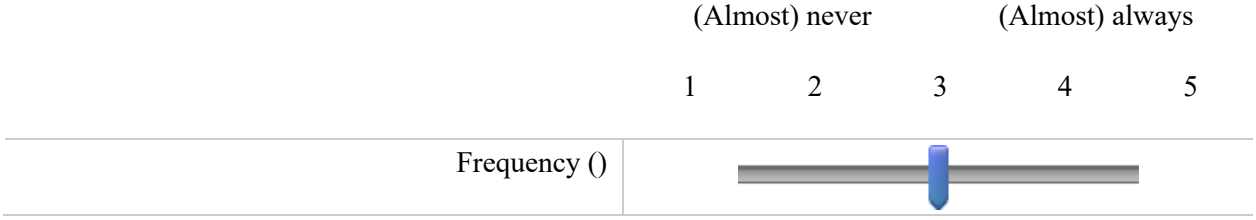
Start of Block: BPS

Q18 For each of the following statements, please decide whether it applies to you using a scale from 1 (almost) never to 5 (almost) always.

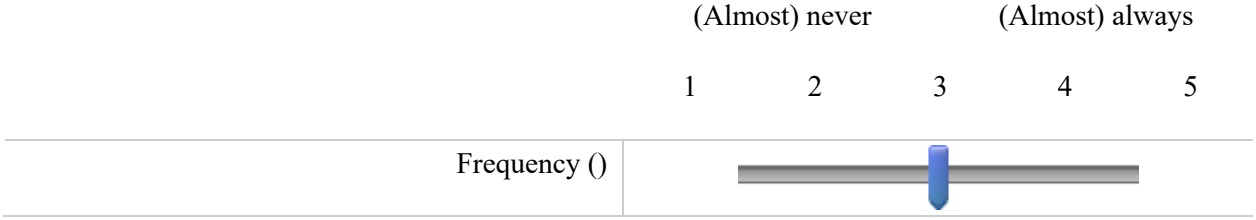
Q13 I go to bed later than I had intended.



Q14 I go to bed early if I have to get up early in the morning.



Q15 If it is time to turn off the lights at night I do it immediately.



Q16 Often I am still doing other things when it is time to go to bed.

Frequency ()	

Q19 I easily get distracted by things when I actually would like to go to bed.

(Almost) never (Almost) always

1 2 3 4 5

Frequency ()	

Q20 I do not go to bed on time.

(Almost) never (Almost) always

1 2 3 4 5

Frequency ()	

Q21 I have a regular bedtime which I keep to.

(Almost) never (Almost) always

1 2 3 4 5

Frequency ()	

Q22 I want to go to bed on time but I just don't.

(Almost) never (Almost) always

1 2 3 4 5

Frequency ()	

Q23 I can easily stop with my activities when it is time to go to bed.

(Almost) never (Almost) always

1 2 3 4 5

Frequency ()	

End of Block: BPS

Start of Block: TIPM

Q24 Please select an option next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.
Please use the following scale:
1- Strongly disagree
2- Moderately disagree
3- Disagree a little
4- Neither agree nor disagree
5- Agree a little
6- Moderately agree
7- Strongly agree

Q25 (I see myself as) Extraverted, enthusiastic

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Rating ()	

Q26 (I see myself as) Critical, quarrelsome

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Rating ()

Q27 (I see myself as) Dependable, self-disciplined

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Rating ()

Q28 (I see myself as) Anxious, easily upset

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Rating ()

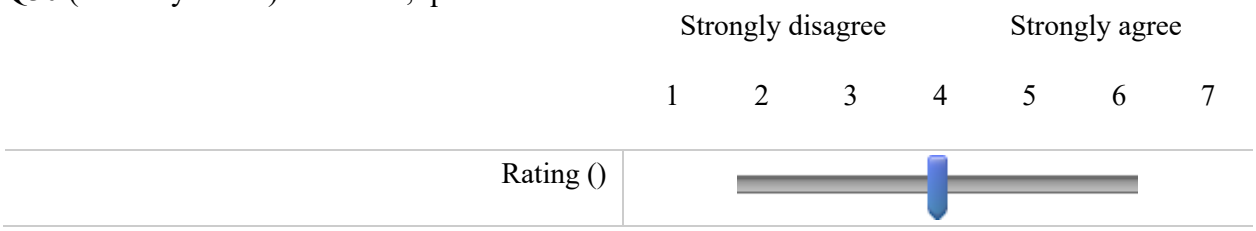
Q29 (I see myself as) Open to new experiences, complex

Strongly disagree Strongly agree

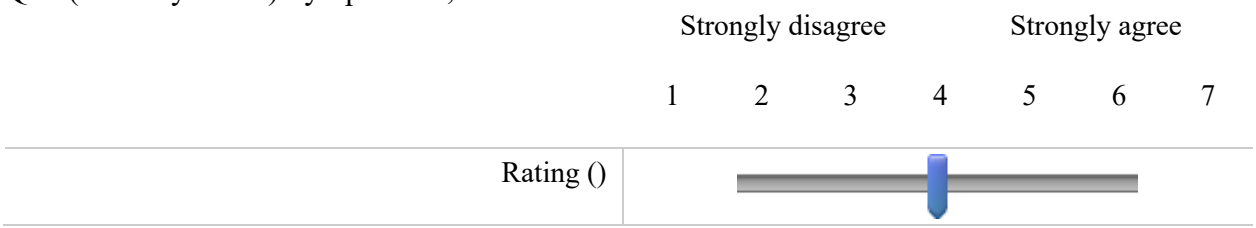
1 2 3 4 5 6 7

Rating ()

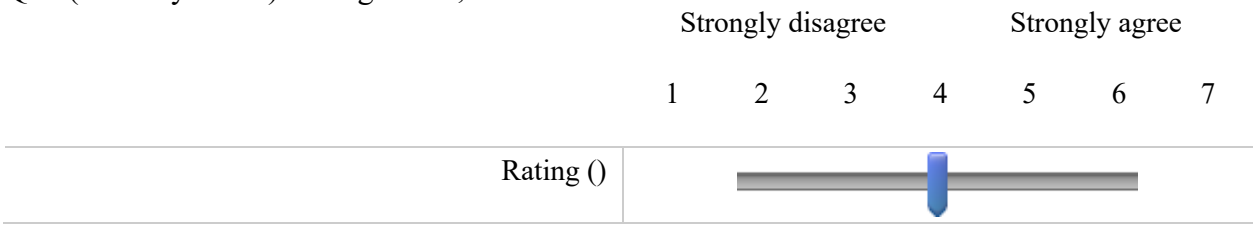
Q30 (I see myself as) Reserved, quiet



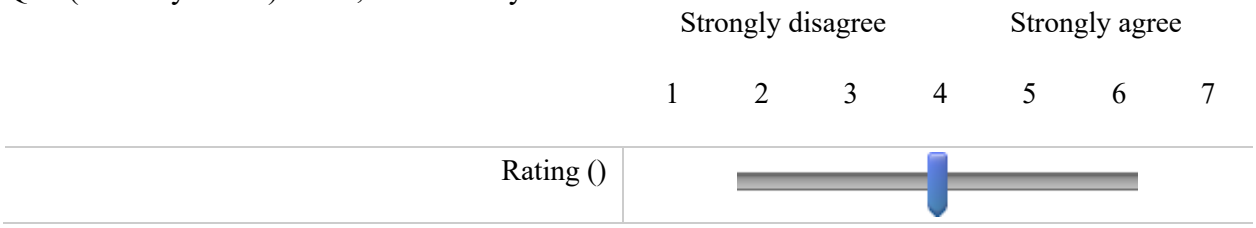
Q31 (I see myself as) Sympathetic, warm



Q32 (I see myself as) Disorganized, careless



Q33 (I see myself as) Calm, emotionally stable



Q34 (I see myself as) Conventional, uncreative

	Strongly disagree					Strongly agree
	1	2	3	4	5	6	7
Rating ()							

End of Block: TIPM

Start of Block: Chronotype rMEQ

Q51 Considering only your own "internal clock," at what time would you get up if you were entirely free to plan your day?

- 5:00 - 6:30 AM (1)
- 6:30 - 7:45 AM (2)
- 7:45 - 9:45 AM (3)
- 9:45 - 11:00 AM (4)
- 11:00 - 12:00 AM (5)

Q52 During the first half hour after having woken up in the morning, how tired do you feel?

- Very tired (1)
- Fairly tired (2)
- Fairly refreshed (3)
- Very refreshed (4)

Q53 At what time in the evening do you feel tired and as a result in need of sleep?

- 8:00 - 9:00 PM (1)
- 9:00 – 10:15 PM (2)
- 10:15 PM – 12:45 AM (3)
- 12:45 – 2:00 AM (4)
- 2:00 – 3:00 AM (5)

Q54 At what time of the day do you think that you reach your "feeling best" peak?

- 5:00 – 8:00 AM (1)
- 8:00 – 10:00 AM (2)
- 10:00 AM – 5:00 PM (3)
- 5:00 – 10:00 PM (4)
- 10:00 PM – 5:00 AM (5)

Q55 One hears about "morning" and "evening" types of people. Which ONE of these types do you consider yourself to be?

- Definitely a "morning" type (1)
- Rather more a "morning" than an "evening" type (2)
- Rather more an "evening" than a "morning" type (3)
- Definitely an "evening" type (4)

End of survey