Sitting with your Problems: Exploring the Relationship between Leisure Screen-based Sedentary Time and Perceived Psychological Stress in University Students, moderated by Gender

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Abstract

Background: University students spend a great part of their free time sitting and watching screens (leisure screen-based sedentary behaviour). Furthermore, psychological stress is especially high in university students which is dangerous due to being associated with adverse health effects. This study was aimed at exploring the relationship between leisure screen-based sedentary time and perceived psychological stress in university students and whether this relation was moderated by gender.

Method: A correlational study design using a cross-sectional setup was employed. The sample consisted of 106 university students, 72 (67.9%) were female, and 86 (81.8%) students were 18 to 25 years old with 74.5% being German. The PAST-U assessed yesterday's sitting time and the PSS measured the perceived psychological stress levels. Pearson's and Spearman's correlations, and moderation analyses were used to examine the relationship between leisure screen-based sedentary time and perceived psychological stress and the moderator variable gender.

Results: Correlation analyses showed no significant findings between the leisure screen-based sedentary time, TV watching and scrolling through social media with perceived psychological stress. Furthermore, all three moderation analyses were statistically insignificant.

Conclusion: The obtained results are unexpected as previous research found gender differences for all investigated variables in university students. Additionally, the non-existent correlations between leisure screen-based sedentary time, including TV watching and scrolling through social media while sitting, and psychological stress indicated positive implications for the sample. Thus, prolonged sitting time during leisure did not increase the already elevated stress levels of university students.

Keywords: Sedentary Behaviour, Leisure Screen-based Sedentary Time, Perceived Psychological Stress, Gender, University Students, Moderation Analysis

Table of Contents

Introduction

While working, driving, watching television, everybody sits every day for multiple hours. Over the last few years, video streaming platforms such as Netflix, Amazon Prime or Disney+ gained increased popularity, now being integrated into the daily routines of many TV series viewers (Flayelle et al., 2020). Due to their affordability, Netflix alone had about 221 million total subscribers by the end of 2021, closely followed by Amazon Prime with about 200 million global subscribers in 2021 and Disney+ which denoted about 130 million total subscribers by the end of 2021 (Maglio, 2022). Evidently, the rising popularity and the easy accessibility of all different kinds of entertainment through media are likely to result in an increase in sitting time among the general population. However, the result of prolonged sitting is detrimental as it is directly related to adverse overall health conditions, such as obesity or an increased risk of cardiovascular diseases (Heron et al., 2019; Klein et al., 2016). Besides physical health consequences, sedentary behaviour can also be associated with mental health problems (Gibson et al., 2017; Hallgren et al., 2020). This study specifically targeted university students as they were likely to already show a high amount of screen-based sedentary behaviour during leisure time as well as being associated with certain mental health problems such as higher psychological stress levels (Sharp & Theiler, 2018). Consequently, the relationship between leisure screen-based sedentary time and perceived psychological stress in university students was investigated. Additionally, the role of gender within this relationship was explored.

Sedentary Behaviour

Generally, sedentary behaviour includes many different activities that are characterised by its energy expenditure being ≤1.5 METs while being in a sitting, reclining or lying position while awake (Tremblay et al., 2017). Moreover, sedentary behaviour can be connected to its occurring context, such as occupation, transport-related or leisure while simultaneously being distinguished into mentally active and mentally passive sedentary behaviours (Hallgren et al., 2020). Within this context, occupational sedentary behaviour describes sitting behaviours during work whereas transportation-related sedentary behaviours incorporate sitting as a passenger in any form of vehicle as well as driving a motor vehicle while sitting (Hallgren et al., 2020). Leisure sedentary behaviours comprise all sitting or lying behaviours that are performed during free time, such as watching television (TV), movies or YouTube videos on any electronic device of choice while sitting or lying down (Hallgren et al., 2020). Combined with behaviours like listening to music while sitting, scrolling through social media or simply

sitting or lying for relaxation purposes without falling asleep, Hallgren et al. (2020) categorise these aforementioned behaviours as mentally passive leisure sedentary behaviours as they require little mental activity to be fulfilled. In contrast, mentally active leisure sedentary behaviours include reading, playing board games or talking to people while being in a sitting or lying position (Hallgren et al., 2020). Consequently, sedentary behaviour is often defined within its specific context taking into consideration the necessary mental effort to accomplish these behaviours.

Within this context, leisure screen-based sedentary behaviour incorporates all sedentary behaviours that are performed in people's free time while fulfilling the condition of watching a screen (Tremblay et al., 2017). According to Caglar et al. (2017), the average leisure screen-based sitting time among university students was 4.3 hours per day. Thereby, watching TV while sitting or scrolling through social media while sitting are the most prominent examples of such behaviour as they are integrated into everyday life, especially among university students (Silva et al., 2017). In connection, the total sedentary time of university students ranged on average between 7 to 11 hours daily (Castro et al., 2020; Moulin et al., 2021). However, increased total sitting time negatively influences people's health, potentially resulting in increased all-cause mortality, cardiovascular disease mortality, cancer risk and risks of metabolic disorders, musculoskeletal disorders and cognitive impairment (Park et al., 2020). In this regard, leisure screen-based sedentary behaviour is often the focus of such research as it is a substantial part of total daily sitting time. Multiple studies found that increased leisure screen time correlates with negative mental health outcomes, increasing the risk of depression, anxiety or experiencing higher levels of psychological stress (Hoare et al., 2016; Zink et al., 2020). Consequently, an association between leisure screen-based sedentary time and psychological stress in university students can be assumed as university students spend a great amount of their free time watching screens while sitting.

Psychological Stress

Stress can be described as a negative emotional state that occurs when individuals perceive themselves as being unable to cope with the current situation as it is more demanding than the individual's adaptive capacity (Cohen et al., 2007). Moreover, stress is strongly associated with nervousness, tension, strain, feelings of worry as well as fatigue (Teychenne et al., 2019). Within this context, psychological stress primarily represents an ongoing issue for university students due to the challenging demands of the university lifestyle, especially when newly transferred to a university (Sharp & Theiler, 2018). The aforementioned negative

emotions could thus potentially influence academic performance and course completion negatively (Sharp & Theiler, 2018). Furthermore, problematic health effects were associated with increased psychological stress levels, particularly for depression, anxiety and cardiovascular diseases (Cohen et al., 2007). According to Asif et al. (2020), around 84.4% of university students indicated to experience psychological stress, 75% reported feelings of depression, as well as 88.4% of university students feeling mild to extremely severe anxiety. The prevalence of increased psychological stress among university students is related to sociodemographic and situational factors, such as the student's current financial situation and gender (Sharp & Theiler, 2018). According to Bayram and Bilgel (2008), female university students in the first two years of their study were related to higher levels of psychological stress. Hence, psychological stress has a great impact on the lives of university students worldwide which might result in devastating physical and mental health outcomes.

Leisure Screen-based Sedentary Time and Psychological Stress

As mentioned above, there has been found growing evidence of a correlation between leisure screen-based sedentary time and psychological stress as amplified screen time use as well as higher media consumption influences people's emotional states, environmental perceptions and cognition (Silva et al., 2017). Within this frame of reference, Silva et al. (2017) found that higher TV viewing while sitting on weekdays increases the perceived stress level among adolescents. Moreover, it was assumed that the connected increased isolation as a result of high screen-based leisure sedentary time could explain the aforementioned positive association as well as the positive relationship concerning the development of later depressive symptoms (Cohen et al., 2007; Hoare et al., 2016; Silva et al., 2017; Werneck et al., 2021). In addition, heightened screen time during leisure is often associated with sleep deprivation leading to fatigue which represents a key characteristic of stress, hence possibly explaining the positive relation (Silva et al., 2017). Consequently, it can be assumed that there is a positive relation between leisure screen-based sedentary time and psychological stress.

In contrast to the previous findings of positive associations between leisure screen-based sedentary time and stress, the systematic review of Zink et al. (2020) indicated inconsistent evidence regarding screen-based sedentary time and its relation to depression and anxiety, which are consequences of elevated psychological stress levels, leading to ambiguous outcomes. Moreover, Teychenne et al. (2019) found no association between TV watching and stress when using objective measures of both constructs compared to finding insufficient evidence when using self-reported measurements. As research about the relationship between

leisure screen-based sedentary time and psychological stress is rather contradictory, it is of great importance to further investigate its possible correlation, in order to develop successful preventive interventions aiming to protect and enhance people's mental health in the future.

Moderation of Gender

Furthermore, inconsistent findings were found for a potential moderation effect of gender on the relationship between leisure screen-based sedentary time and stress (Zink et al., 2020). Gender represents an important factor in people's vulnerability to psychological stress (Wang et al., 2007). This is supported by gender-specific neural activation pathways in response to stress which can explain the differences in vulnerability (Wang et al., 2007). As mentioned above, female university students are more susceptible to greater levels of psychological stress (Bayram & Bilgel, 2008) while simultaneously being more vulnerable to developing depression or anxiety which highly correlate with elevated stress levels (Cohen et al., 2007; Wang et al., 2007). Additionally, various studies outlined gender differences in the averages of leisure screen-based sedentary time (Caglar et al., 2017; Fountaine et al., 2011; Rouse & Biddle, 2010). In support, the association between leisure screen-based sedentary behaviour and depressive symptoms is amplified when being female compared to being male (Zink et al., 2020). Thus, a moderation effect of gender on the correlation between screen-based leisure sedentary time and psychological stress is plausible but is in need of further investigation.

Relevance

The abovementioned contradictory findings regarding stress show a gap in research representing the relevance of this study. Some studies support the relationship to leisure screen-based sedentary time whereas others do not. This inconsistency also relates to the association between leisure screen-based sedentary behaviour and the psychological disorders depression and anxiety which are directly related to psychological stress, further showing the need for a thorough investigation as a connection is plausible (Zink et al., 2020). Furthermore, it is important to examine the existence and the strength of the moderation effect of gender as it might influence the findings showing differing results for different genders (Zink et al., 2020). In addition, the research about the usage of social media is limited as it portrays a rather modern form of leisure screen-based sedentary behaviour, thus showing another gap in research. It is hypothesised that high levels of social media use might have a detrimental influence on people's mental health, including a positive correlation which high stress levels (Teychenne et al., 2019; Zink et al., 2020). This study aimed to take all these aspects into account in order to fill this gap

in research on which opportunities for preventive interventions aiming to improve people's mental health can build upon.

The Present Study

Thus, the goal of this study is to analyse the relationship between leisure screen-based sedentary time and the perceived psychological stress level of university students while investigating a potential interaction effect with gender on this association (Figure 1).

Figure 1

Draft of moderation model of the present study
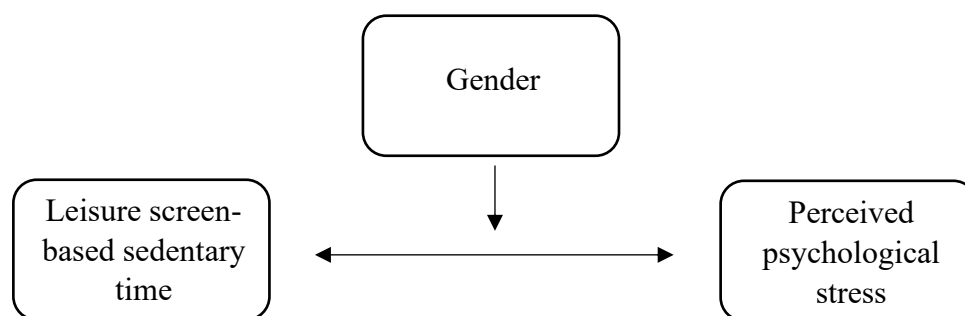
Therefore, this study will investigate two research questions by testing the respective hypotheses:

RQ1: To what extent does leisure screen-based sedentary time correlate with the perceived psychological stress level in university students?

H1: Total leisure screen-based sedentary time is positively associated with higher perceived psychological stress levels in university students.

H2: Sitting while watching TV (television, DVDs, videos on demand, YouTube) is positively associated with higher perceived psychological stress levels in university students.

H3: Sitting while scrolling through social media (Instagram, Facebook, Twitter, TikTok, etc.) is positively associated with higher perceived psychological stress levels in university students.

RQ2: To what extent does gender moderate the relationship between leisure screen-based sedentary time and the perceived psychological stress level in university students?

H4: Gender moderates the relationship between total leisure screen-based sedentary time and perceived psychological stress in university students.

H5 Gender moderates the relationship between sitting while watching TV and perceived psychological stress in university students.

H6: Gender moderates the relationship between sitting while scrolling through social media and perceived psychological stress in university students.

The sub behaviours of total leisure screen-based sedentary time, namely TV watching and scrolling through social media were chosen as both behaviours gained increased popularity among university students. Moreover, TV watching was investigated due to its inconsistent findings related to stress, stating, on the one hand, an association with psychological stress (Silva et al., 2017) whereas, on the other hand, showing no association (Teychenne et al., 2019). Additionally, scrolling through social media was investigated because there were very limited findings regarding its relation to psychological stress because social media is a relatively modern form of leisure screen-based sedentary behaviour resulting in solely hypothesising about its potential effect on psychological stress (Teychenne et al., 2019; Zink et al., 2020). Therefore, both behaviours are in need of further clarification.

Methods

Design

A correlational study design using a cross-sectional setup was employed. The variables leisure screen-based sedentary time, TV watching, scrolling through social media and gender as well as the variable stress were investigated. Furthermore, the data was collected in collaboration with a group of four researchers investigating sedentary behaviour and its potential association with other constructs, namely mood, sleep quality, divergent thinking, social anxiety, neuroticism and extraversion. Moreover, this study was approved by the BMS Ethics Committee (request number 220299). The data collection took place in the period from 06 April 2022 until 18 May 2022.

Participants

Convenience sampling was used to recruit participants. The survey was available on the survey distribution application SONA Systems where students from the University of Twente could apply for participating in this study in exchange for 0.25 credits. Moreover, the online link to the questionnaire was shared via WhatsApp, Facebook and Instagram as a means to recruit students from other universities as well. For participating in this study, three inclusion criteria needed to be met: participants needed to be university students, fluent in English, and 18 years old or older. To achieve 95% statistical power for the moderation analysis, with a

significance level of .05, the computer software G*Power (version 3.1.9.7) was used indicating a required sample size of 89 participants.

Materials

Assessment of Leisure Screen-based Sedentary Time

In order to measure the different types of leisure screen-based sedentary behaviour, an adapted version of the Past Day Sedentary Time – University (PAST-U) questionnaire was used (Clark et al., 2016). This questionnaire is a modified version of the original PAST questionnaire developed by Clark et al. (2013) as it specifically targets the sedentary behaviour of university students (Clark et al., 2016). The original PAST-U consists of 9 questions asking about the sedentary behaviour of the previous day within the context of study, work, transport, television viewing, computer/internet/electronic games, reading, eating, socialising, and sitting/lying for other purposes. The posed questions needed to be answered in hours and minutes, for example, "How long were you sitting while studying yesterday?", which should provide more accurate times. Consequently, the self-reported questionnaire represents a more accurate measurement of sedentary behaviour compared to single-item surveys which can be explained by the usage of multiple items including various contexts that are rather specific (Prince et al., 2020). The PAST-U showed acceptable criterion validity (ICC = .64; mean difference= 0.08h; SD = 2.04h) (Clark et al., 2016).

However, the PAST-U was modified by the researchers intending to tailor the items according to the to-be-answered hypotheses. Consequently, the two items "Please estimate the total time you spent sitting or lying down to watch TV or DVDs or play games on the TV, such as PlayStation/Xbox yesterday?" and "Please estimate the total time yesterday that you spent sitting or lying down and using the computer." were altered to separate the specific leisure screen-time contexts (Appendix A). Therefore, one item is focused on watching TV, DVDs, videos-on-demand or YouTube on any electronic device whereas another item asks about the participant's sedentary behaviour while scrolling through social media, one example being "Please estimate the total time yesterday that you spent sitting or lying down and scrolling through social media (e.g., Instagram, Facebook, Twitter, TikTok, etc.)." Thus, the original two questions within the context of leisure screen-based sedentary behaviour were extended to in total six items to achieve greater accuracy in measuring the time spent doing leisure screen-based sedentary behaviours among university students.

Assessment of Stress

To measure the individual stress level among university students, the perceived stress scale (PSS) developed by Cohen et al. (1983) was used as a classic stress assessment instrument. The questionnaire consists of 10 questions asking about participants' feelings and thoughts in relation to perceived stress, specifically indicating the experience of life's unpredictability, uncontrollability as well as general overload during the past month (Klein et al., 2016). Participants needed to answer the items in regards to how often they felt or thought that specific way by choosing between 0 = never to 4 = very often (Appendix B). As the items are rather general, for instance "In the last month, how often have you felt nervous and stressed?", the PSS can be applied amongst a broad population. Depending on the culture and the country, the PSS shows good reliability as Cronbach's alpha ranges from .78 to .91 while showing satisfactory test-retest reliability (Klein et al., 2016). Moreover, the PSS demonstrates good construct validity by showing moderate to strong correlations with depression and anxiety. The 10-item questionnaire has often been used for evaluating stress among university students (Chai & Low, 2015) showing reliable and valid results that do not seem significantly affected by gender bias (Denovan et al., 2019).

Demographic Variables

Participants were asked about their demographics by means of a questionnaire about their (1) gender, (2) age and (3) nationality where they could choose between (1) being female, male or non-binary/third gender, between (2) being 18-25 years old, 26-30 years old, 31-40 years old, 41-50 years old and being 51 years old or older and between (3) having a Dutch, a German or another nationality (Appendix A).

Procedure

After approving the study by the BMS Ethics Committee, the link to the study was shared on the SONA Systems website. When deciding to start the survey, an active informed consent form was presented first, entailing information about the study as well as its purpose, the duration of the study, anonymity, confidentiality and the possibility to withdraw from the study at any given point in time (Appendix A). The participant needed to give their informed consent in order to be able to participate in the study. Afterwards, the demographic questions had to be answered followed by the modified version of the PAST-U, the PSS and the questionnaires of the other four researchers which took the participants on average 20 to 30 minutes to answer. After answering all questions, the participants were thanked for their effort and time.

Data Analysis

The gathered data was analysed using SPSS Version 27. The data set was prepared by calculating the total sedentary time, the total leisure screen-based sedentary time and computing the total score of the PSS by adding all relevant variables together, taking into consideration the reversed values for four items of the PSS meaning that the value of 4 was reversed to the value of 0 and vice versa. Moreover, participants who did not answer one or both questionnaires were deleted from the data set. In addition, the assumption of normality was assessed by the Shapiro-Wilk test and visual assessment of normal Q-Q plots and histograms. To account for linearity and homogeneity of variance, Levene's test of equality of error variances was calculated combined with plotting the residuals and visualising them on a scatterplot. Furthermore, boxplots of the respective residuals labelled by gender, age and nationality were used to test for the assumption of multicollinearity.

The first step of the data analysis was the computation of means, standard deviations, and minimum and maximum of the variables. In addition, Cronbach's alpha was computed for the variable "stress" to examine its internal consistency. Afterwards, the hypotheses H1, H2 and H3 were tested using correlational analysis. Thus, Pearson's correlation coefficients or Spearman's correlation coefficients were calculated for these variables. $p < .05$ indicated significant correlations (Cohen, 1988).

Lastly, the SPSS extension PROCESS 4.0 by Andrew Hayes (Hayes, 2012) was utilised in order to investigate the moderation effects of gender on the relationship between leisure screen-based sedentary time, TV watching, scrolling through social media and the variable "stress". Therefore, with the moderation analysis, H4, H5 and H6 were investigated. Consequently, three moderation analyses needed to be conducted. In order to show a statistically significant moderation effect, the respective general model and both effects within the model should have a $p < .05$.

Results

Descriptive Statistics

The initial reported sample consisted of 142 participants. Before conducting analyses, the responses of 36 participants were excluded from the study. 28 of the 36 failed to fill out one or both questionnaires. Additionally, one outlier was deleted because the PSS was only answered halfway through and always with the same response category although one reversed item was already answered, hence the participant seemed to have not responded truthfully. To determine further exclusion criteria from the data set for reporting high total scores for leisure

screen-based sedentary time, Pearson's *r* was calculated showing an insignificant correlation between the total score of sedentary time and the total score of leisure screen-based sedentary time ($r(104) = .1$; $p = .31$). Therefore, seven participants were excluded that reported a total leisure screen-based sedentary time score of ten hours or more if the total score of overall sedentary time exceeded 24 hours. Thus, the data set still included the participants that reported a total sedentary time score above 24 hours when simultaneously indicating reasonable total leisure screen-based sedentary time scores equal to or under ten hours. Consequently, the final sample size consisted of 106 participants meaning that the required sample size of 89 which was suggested by G*power analysis was achieved.

As a result, 72 (67.9%) of the final sample were female, and 34 (32.1%) were male (see Table 1). Furthermore, 86 respondents reported being in the range from 18 to 25 years old, whereas 18 participants were between 26 and 30 years old. With 74.5%, the majority of the sample had a German nationality, followed by 14.2% indicating another nationality besides German or Dutch (see Table 1).

Table 1

Sociodemographic characteristics of the final sample

Characteristic		*n*	%
Gender			
	Female	72	67.9
	Male	34	32.1
Age			
	18-25 years old	86	81.1
	26-30 years old	18	17
	31-40 years old	2	1.9
Nationality			
	Dutch	12	11.3
	German	79	74.5
	Other [a]	15	14.2

Notes: $N = 106$ participants. [a] Other included nationalities were Lithuanian, Belgian, Polish, Ukrainian, British, French, Israeli, Turkish, Swedish, American, Croatian, Bulgarian, and Vietnamese.

Overall, participants reported on average a total leisure screen-based sedentary time of 5.5 (*SD* = 2.7) hours (see Table 2). Furthermore, the respondents indicated to spend on average 2 (*SD* = 1.5) hours watching television, DVDs, videos-on-demand or YouTube on an electronic device, complementary to scrolling on average 1.2 (*SD* = 1) hours on social media, for example on Instagram, Facebook or TikTok. In addition, participants reported on average a total stress score of 20.1 with a minimum score of 4 and a maximum score of 35 (see Table 2). Within this context, it is important to mention that the highest possible score in regards to stress is 40 showing that the mean is about half of the possible score, thus representing moderate stress levels.

Table 2

Descriptive statistics of leisure screen-based sedentary times and stress scores

	M	*SD*	Min	Max
Total leisure screen-based sedentary time in minutes (in hours)	323.61 (5.39)	163.17 (2.72)	0 (0)	810 (14)
TV watching in minutes (in hours)	119.10 (1.99)	89.53 (1.49)	0 (0)	390 (6.5)
Scrolling through social media in minutes (in hours)	70.36 (1.17)	56.33 (0.94)	0 (0)	240 (4)
Stress	20.09	6.57	4	35

To analyse the internal consistency of the PSS, Cronbach's alpha was computed showing high reliability (α = .86) of the perceived stress scale (Appendix C). A Shapiro-Wilk test showed that the variables "TV watching" ($W(106)$ = 0.94, p < .001) and "Scrolling through social media" ($W(106)$ = 0.88, p < .001) are not normally distributed as both posed a chance of less than 1% to find the respective data in a random sample (Appendix D). These results were also supported by the Kolmogorov-Smirnov test showing for both aforementioned variables a significance level below .05 (Appendix D). In contrast, according to the Shapiro-Wilk test, the variables "total leisure screen-based sedentary behaviour time" ($W(106)$ = 0.98, p = .20) and "stress" ($W(106)$ = 0.99, p = .68) both are normally distributed (Appendix D). Evidently, the difference of a normal distribution for all four variables is visualised by Q-Q plots as well as the respective histograms (Appendix D).

Moreover, by computing Levene's test, it is evident that all four variables show equality of variance as all exceed the significance level of 5%, thus indicating no differences in variance and fulfilling the assumption of homogeneity of variance (Appendix E). The assumption of multicollinearity is additionally met which is visualised through computed boxplots that show relatively similar results for all four variables categorised by gender, age and nationality (Appendix F). Although the assumption of linearity is weak which is visualised by plotting the residuals on scatterplots (Appendix G), correlation and moderation analyses can be conducted. Consequently, almost all assumptions are met, except for the normality for the variables "TV watching" and "Scrolling on social media".

Correlation Analysis

In order to answer H1, Pearson's correlation was conducted. Due to not being normally distributed, Spearman's rho was conducted helping to answer H2 and H3. A small positive correlation was found between total leisure screen-based sedentary time and stress, but was statistically insignificant ($r(104) = .12$, $p = .21$). This indicated that there was no significant association between participants scoring high on psychological stress as well as on their total leisure screen-based sedentary time. Consequently, H1 *Total leisure screen-based sedentary time is positively associated with higher perceived psychological stress levels in university students* was rejected.

Moreover, an insignificant correlation was found between sitting while watching television, DVDs, videos on demand or YouTube and stress among university students. This result was supported by Spearman's rho which indicated no significant correlation between the two variables ($\rho(104) = .03$, $p = .80$). Therefore, participants who indicated higher levels of TV watching do not score higher on the PSS meaning that H2 *Sitting while watching TV (television, DVDs, videos on demand, YouTube) is positively associated with higher perceived psychological stress levels in university students* was rejected.

A small positive correlation was found between scrolling on social media and stress but was statistically insignificant ($\rho(104) = .13$, $p = .17$). Participants who reported to spend more time scrolling on social media did not score significantly higher on the PSS. Thus, H3 *Sitting while scrolling through social media (Instagram, Facebook, Twitter, TikTok, etc.) is positively associated with higher perceived psychological stress levels in university students* was rejected.

Moderation Analysis

In order to test H4, H5 and H6, three moderation analyses were conducted (see Table 3). The first moderation analysis was run to determine whether an interaction effect between

gender and total leisure screen-based sedentary time significantly predicted a higher perceived psychological stress level in university students. The overall model was nearly significant, $F(3,102) = 2.36$, $p = .076$, predicting 25.48% of the variance. Furthermore, the results showed that gender did not moderate the relationship between total leisure screen-based sedentary time and stress significantly ($B = 0.00$, $t = 0.36$, $p = .721$). Thus, H4 *Gender moderates the relationship between total leisure screen-based sedentary time and perceived psychological stress in university students* was rejected.

The second moderation analysis was run to determine whether an interaction effect between gender and TV watching significantly predicted a higher perceived psychological stress level in university students. The overall model was insignificant, $F(3,102) = 1.59$, $p = .196$, nevertheless predicting 21.16% of the variance. Additionally, the results did not show that gender moderated the relationship between TV watching and stress significantly ($B = -0.01$, $t = -0.66$, $p = .509$). Therefore, H5 *Gender moderates the relationship between sitting while watching TV and perceived psychological stress in university students* was rejected.

The third moderation analysis was run to determine whether an interaction effect between gender and scrolling through social media significantly predicted a higher perceived psychological stress level in university students. The overall model was nearly significant, $F(3,102) = 2.37$, $p = .075$, predicting 25.52% of the variance. Moreover, the results did not show that gender moderated the relationship between scrolling through social media and stress significantly ($B = 0.02$, $t = 0.86$, $p = .392$). Consequently, H6 *Gender moderates the relationship between sitting while scrolling through social media and perceived psychological stress in university students* was rejected.

Table 3

Moderation analyses for the different variables and the three interaction effects for the variable perceived psychological stress

		B	*SE*	*t*	*p*	*95% Confidence interval*	
						Lower Bound	*Upper Bound*
H4	Screen-based sedentary behaviour time	0.00	0.01	0.16	.877	-0.02	0.03
	Gender	2.17	2.96	0.73	.465	-3.71	8.05
	Screen-based sedentary behaviour time x Gender	0.00	0.01	0.36	.721	-0.01	0.02
H5	TV watching	0.02	0.03	0.74	.463	-0.03	0.07
	Gender	3.99	2.26	1.76	.081	-0.50	8.48
	TV watching x Gender	-0.01	0.02	-0.66	.509	-0.04	0.02
H6	Scrolling through social media	-0.02	0.04	-0.44	.662	-0.01	0.06
	Gender	1.36	2.15	0.63	.529	-2.91	5.63
	Scrolling through social media x Gender	0.02	0.02	0.86	.392	-0.03	0.07

Discussion

This study was aimed at investigating the relationship between leisure screen-based sedentary time and perceived psychological stress in university students. Complementary, the role of gender as a moderator of this relationship was examined. In regards to the first research question *To what extent does leisure screen-based sedentary time correlate with the perceived psychological stress level in university students?* the results showed that leisure screen-based sedentary time including its two distinctive sub-behaviours did not seem to be related to the perceived psychological stress level of university students. The second research question *To what extent does gender moderate the relationship between leisure screen-based sedentary time*

and the perceived psychological stress level in university students? was answered as gender was not found to moderate the relationship between leisure screen-based sedentary time and perceived psychological stress in university students.

Evaluation of Correlation Analysis

The obtained results are rather surprising as there seems to be no correlation between leisure screen-based sedentary time and psychological stress. Another surprising finding was that TV watching was not correlated with increased stress levels either. One possible explanation might be the stress-reducing effect of playing a casual video game among university students so that they consciously decide to spend their leisure time sitting and playing video games as it significantly reduces their experienced daily stress levels (Desai et al., 2021). In support, Silva et al. (2017) stated that playing computer/video games is negatively related to higher perceived stress levels among adolescents. The specific behaviour of playing computer/video games on any electronic device is included in the total leisure screen-based sedentary time meaning that it could account for the found non-existing relationship to elevated psychological stress levels due to representing a stress-reducing method for university students.

Furthermore, the insignificant correlation between scrolling through social media and stress is unexpected as previous research stated that the usage of social media overall can lead to adverse mental health effects such as an increase in psychological stress or self-injurious behaviour among adolescents (Abi-Jaoude et al., 2020). However, adolescents differ from university students. Adolescents are in an increasingly more vulnerable and critical period in their lives trying to find an identity and struggling with self-image (Erikson, 1968). Through growing up in times of social media, adolescents' identity formation is likely to be influenced by these external factors which could explain its correlation to stress and adverse mental health outcomes (Granic et al., 2020). In contrast, the current study found no such correlation in university students although showing elevated psychological stress levels amongst them. Arguably, the target group was stressed, but not due to scrolling through social media while sitting, watching TV while sitting or their total leisure screen-based sedentary time. In support, Teychenne et al. 2019 reported strong evidence for no association between TV watching with stress. These insignificant correlations are thus great news for the sample showing that leisure screen-based sedentary time has not as detrimental mental health effects for university students as expected beforehand.

Evaluation of Moderation Analysis

The statistically insignificant moderation effect of gender in all three moderation analyses was unexpected taking into consideration previous research concerning the effect of gender on every respective variable. Thus, it was previously established that female university students were more susceptible to increased levels of psychological stress (Bayram & Bilgel, 2008). Furthermore, gender differences were found in performing different types of leisure screen-based sedentary behaviour, hence female adolescents were more likely to spend more time on social media than male adolescents (Abi-Jaoude et al., 2020). Various research stated that male university students were more likely to have overall higher leisure screen-based sedentary time compared to their female counterparts with the greatest difference being the engagement in playing computer/video games (Fountaine et al., 2011; Iannotti et al., 2009; Karaca et al., 2011). However, this behaviour was not specifically analysed in this study, so it could solely impact the total leisure screen-based sedentary time score which was checked beforehand fulfilling the assumption of multicollinearity. As mentioned above, playing video games was associated with a stress-reducing effect (Desai et al., 2021), hence impacting its relationship to stress while showing a potential moderation effect of gender. Thus, it can be concluded that gender did not moderate the relationship between leisure screen-based sedentary time, including TV watching and scrolling through social media, and perceived psychological stress in university students, despite its occurring gender differences for all mentioned variables.

Evaluation of Sample

Overall, the sample reported on average 5.5 hours of leisure screen-based sedentary time per day which was higher than the previously reported average of about 4 hours per day (Caglar et al., 2017). This could be explained by the gaining popularity of social media which might consequently increase the average time spent scrolling on social media. According to Auxier and Anderson (2021), 71% of American 18- to 29-year-olds reported using Instagram, 70% use Facebook, 65% use Snapchat and 48% use TikTok which portrays the general trend regarding the usage of social media among young adults. Moreover, streaming platforms such as Netflix, Amazon Prime or Disney+ showed an increasing number of subscribers (Flayelle et al., 2020; Maglio, 2022) which could also account for the higher average of leisure screen-based sedentary time. In support, 95% of 18- to 29-year-olds reported using YouTube (Auxier & Anderson, 2021) illustrating the great amount of time spent watching screens. Consequently, the general trend of social media use and TV watching through various platforms could account

for the raised average of 5 hours of leisure screen-based sedentary time.

The average score of stress being 20 out of 40 generally indicated moderate stress levels (Cohen & Williamson, 1988). However, the norm table for 18- to 29-year-olds, which was with around 98% the primary age group of the current study, indicated an average of 14 (Cohen & Williamson, 1988). Although there are no clear cut-off points for the PSS score, a score of 14 is generally considered as being on the lower bound of moderate stress (Cohen & Williamson, 1988). Thereby, the reported findings showed that university students experienced higher stress levels than expected. As above mentioned, particularly females were increasingly susceptible to psychological stress (Cohen & Janicki-Deverts, 2012; Bayram & Bilgel, 2008; Sharp & Theiler, 2018). This could account for the raised average of perceived psychological stress in this sample as around 68% are female. Due to their added elevated susceptibility to psychological stress, adverse health effects including serious physiological and mental illnesses are likely to occur (Cohen et al., 2007). Thereby, it remains of great importance to develop preventive interventions aiming to improve the sitting behaviour and reduce the stress levels of university students to avoid such devastating, however preventable outcomes.

Limitations and Strengths

This study contained limitations that need to be evaluated carefully when interpreting the obtained results. First, the memory bias needed to be taken into account when reporting the results. Both assessment forms, the modified PAST-U and the PSS, are self-reported measurements, thereby asking about sitting time from the day before participating in the study or the negative feelings associated with stress in the last month. Therefore, the results relied upon the memory of the participants which could easily be distorted as the overall duration of sitting behaviour was often underestimated (Hallgren et al., 2020; McLaughlin et al., 2020).

Within this frame of reference, the PAST-U asked about the sitting behaviour from the day prior. However, the respective day that was reported might influence the results to some degree. Thus, there is growing evidence that there is a difference in sitting time between weekdays and weekends among university students (Gibson et al., 2017; Juren et al., 2020) indicating that leisure screen-based sedentary behaviour is likely to differ on weekdays or weekends as well. According to Salmon et al. (2003), the weather was related to sedentary behaviour meaning that bad weather conditions, such as rain, might increase leisure screen-based sedentary time among university students, hence altering the obtained results. Therefore, due to the occurring memory bias as an implication of self-reported measurements and the dependency on the respective day the study was conducted, the obtained results might be

distorted and need to be regarded with caution.

Moreover, another limitation regards the distribution of gender within the obtained sample. 67.9% of the final sample were female and approximately a third were male. Due to investigating a moderation effect, it would have been advisable to have an equal distribution of gender as the 34 male participants are likely to be under-representative of the male university student population.

In contrast, one clear strength of the study was the investigation of the sub-behaviour "scrolling through social media" representing a gap in previous research which solely hypothesised its effect on psychological stress and rather focused its investigations on TV watching or playing computer/video games when talking about leisure screen-based sedentary behaviour and stress (Teychenne et al., 2019; Zink et al., 2020). Moreover, this study was one of the first studies to investigate the relationship between leisure screen-based sedentary time and psychological stress accompanied by an interaction effect of gender among the respective target group. Oftentimes, the two concepts were analysed regarding university students, but the connection was seldomly drawn as in this case, hence most research targeted other age groups such as adolescents or adults. Therefore, university students were often left out although posing an increased prevalence of higher levels of stress as well as leisure screen-based sedentary time. With this study, the gap in research can consequently be filled.

Future Research Recommendations

Based on the previously mentioned limitations, various recommendations for future research can be presented. Hence, changing the study design from a cross-sectional setup to an experience sampling method would be beneficial to account for the limitation of the memory bias (Pejovic et al., 2016) and for the influence of the respective day including differing weather conditions on the given answers of the PAST-U. Therefore, the experience sampling method should be used for a specific time frame of one or two weeks. Furthermore, this study design would be useful in gathering more in-depth insights and thus exploring the link between the variables more extensively.

An additional recommendation would be the incorporation of unobtrusive physiological measurements to assess leisure screen-based sitting time and stress which would again account for the memory bias and the limitations of solely relying on self-reported measurements. Thus, future research could, for example, refer to the option of smartphones showing the respective screen times of the used social media apps which could help to avoid underestimating the duration of its usage and thus influence the given answers on leisure screen-based sitting time.

Furthermore, physiological stress measurements such as measuring heart rate or blood pressure could be incorporated in future research, for example, using an electronic blood pressure cuff which could be easily administered by the participants themselves before and after engaging in leisure screen-based sedentary behaviour. However, perceived psychological stress and physiological stress describe different constructs meaning that experiencing psychological stress might not influence an individual's heart rate or blood pressure. Therefore, the results of unobtrusive physiological stress measures and self-reported stress measures might differ. An approach incorporating both self-reported questionnaires and unobtrusive measurements would increase the reliability of the obtained results by checking for differences between the results and thus, avoid the implication of memory bias or other not foreseeable external dependencies.

Alongside gender, socio-economic status (SES) as another possible moderator could be investigated as it might be related to the present study. Accordingly, SES influences the averages in leisure screen-based sitting time as students with a lower SES might lack certain electronic devices, thus having less opportunity to engage in leisure screen-based sedentary behaviour compared to students with a higher SES (Caglar et al., 2017; Deliens et al., 2015; Mielke et al., 2014). Furthermore, university students from a lower SES might use their leisure time working (Walpole, 2003) which results in less opportunity to engage in leisure screen-based sedentary behaviour. In this regard, the perceived stress level of university students is related to their current financial situation meaning that students from a lower SES that worried more about money showed higher stress levels compared to students in a secure financial situation (Jury et al., 2017; Sharp & Theiler, 2018). Thereby, including economic status as a moderator in this study might further explain and alter the obtained results.

Conclusion

In conclusion, this study shows support for the assumption that leisure screen-based sedentary time, including its sub-behaviours namely TV watching and scrolling through social media, has no influence on the perceived psychological stress level of university students. Therefore, leisure screen-based sedentary time did not seem to affect students' mental health as badly as expected beforehand which is great news as university students showed prolonged sitting time during leisure. Additionally, no gender differences can be found within these non-existent correlations. Nevertheless, this study obtained meaningful results about leisure screen-based sedentary time as well as psychological stress levels in university students which are still an ongoing issue in their daily life, each posing detrimental risks for their physical and mental health. Therefore, leisure screen-based sedentary behaviour requires further research to closely

examine how university students' screen-based sitting time during leisure as well as their elevated psychological stress levels can be reduced.

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Appendices

Appendix A: Modified Version of the PAST-U Questionnaire

Thank you very much for your interest in participating in this study on sitting behaviour. Please read the following information carefully.

We, a group of 3rd-year-psychology students, created this study as part of our Bachelor theses under the supervision of Gerko Schaap. We are interested in investigating the relationship between sitting behaviour and mental health concepts, such as anxiety, mood, and stress among university students. Sitting behaviour also includes activities in a reclining position or lying down. Examples of sitting behaviours are watching television, reading, driving, or studying while sitting.

The study will take approximately 30 minutes. You are asked to answer several questionnaires which will help us to analyse the relationship between sedentary behaviour and concepts of mental health. As a potential risk and/ or benefit, it may be that you become aware of, for instance, your stress, positive or negative mood, and how much you sit.

By taking part in this study, no personally identifiable information will be gathered, and your privacy will be ensured at any times. The results that we gather will be stored safely and are only available to the researchers and the supervisor. After we completed our theses, the data will be deleted. Your answers to the questionnaire stay completely anonymous. Participation is fully voluntary in this study. In case you participate, you can withdraw at any time without a reason or negative consequences. In case you have any questions or concerns about this study, feel free to contact the researchers.

What is your gender?

   a. Female
   b. Male
   c. Non-binary/ third gender

2. Please indicate your age below:
   a. 18-25 years
   b. 26-30 years
   c. 31-40 years

      d.   41-50 years

      e.   51 years or older

3.   What is your nationality?

      a.   Dutch

      b.   German

      c.   Other

4.   What is the name of your study program?

We are going to ask you about particular activities you did yesterday while sitting down or lying down. Please note that this does not include sleeping, either in bed or if you fell asleep while doing another activity, for example watching television.

We are going to ask you about different times when you may be sitting or lying down: when studying, working, travelling, watching TV, using the computer, and doing other activities. **For each of these, only count the time this was your main activity!** For example, if you watched TV and ate dinner at the same time, this might be TV or meal time, but not both.

Your answers can be given in hours and minutes. Try to report only the time you spent sitting or lying down and do not take into account the time you spent getting up for breaks (e.g. coffee, bathroom).

Please indicate the time **as precisely as possible**.

Example: Please indicate the **total** sitting time in the bus yesterday.

Hours: 2

Minutes: 40

1.   How long were you sitting while studying yesterday? (include the time at university, during lectures, tutorials, meetings, group discussions, self-study, study from home, etc.)

2.   How long were you sitting at your workplace or working from home in a paid position yesterday? (Examples: babysitting, sitting at the reception, minding a stall/shop, data entry/administrative paper work, tutoring, etc.)

3. Thinking again of yesterday, please estimate the **total** time that you spent sitting to travel from one place to another **only as a passenger.** Please include sitting and waiting for transport. Do **not** include any time you were standing up while travelling or waiting.

4. Thinking again of yesterday, please estimate the **total** time that you spent sitting to travel from one place to another **while you were the driver**? This does **not** include physically active driving, such as bicycling.

5. Please estimate the **total** time you spent sitting or lying down to watch TV, DVDs or watch videos-on-demand, YouTube etc. on your computer/tablet/phone or other electronic devices yesterday? This includes if you watch TV in bed.

6. Please estimate the **total** time yesterday that you spent sitting or lying down and playing computer or video games using the computer or any other electronic devices (e.g. Xbox, Playstation, etc.).

7. Please estimate the **total** time yesterday that you spent sitting or lying down and scrolling through social media (e.g. Instagram, Facebook, Twitter, TikTok, etc.).

8. Please estimate the **total** time yesterday that you spent sitting or lying down while engaging with other people directly via screens (e.g. by using WhatsApp, Facebook messenger, or other messenger apps).

9. Please estimate the **total** time yesterday that you spent sitting or lying down while reading **during your leisure time** on a smartphone, tablet or any other electronic device (e.g. reading on a kindle). Include screen-based reading in bed but do **not** include time spent reading for paid work or for study.

10. Please estimate the **total** time yesterday that you spent sitting or lying down and using screens that were not described above and that were not for studying or working purposes (e.g. online shopping, etc.).

11. Please estimate the **total** time yesterday that you spent sitting or lying down while reading paper-based books **during your leisure time**. Include reading in bed but do **not** include time spent reading for paid work or for study.

12. Please estimate the **total** time yesterday that you spent sitting down for eating and drinking, including meals and snack breaks.

13. Please estimate the **total** time yesterday that you spent sitting down to socialize with friends or family, regardless of location (at university, at home or in a public place).

14. We are interested in any other sitting or lying down that you may have done that you have not already told us. For example, this could include; hobbies such as doing art

and craft, playing board games or for religious purposes. Again thinking of yesterday, please estimate the **total** time that you spent sitting or lying down **NOT** including the time that you have told us about in the previous answers.

You finished the main part of the survey. Thank you for your participation.

After completing it, do you have any thoughts/ questions/ suggestions/ anything you want to add? Please feel free to do so, because it helps us create better surveys in the future.

We thank you for your time spent taking this survey.

Your response has been recorded. Now, you can safely close the tab, window or browser.

In case you have questions or concerns about this study, feel free to contact the researchers.

Appendix B: Perceived Stress Scale

1. In the last month, how often have you been upset because of something that happened unexpectedly?
2. In the last month, how often have you felt that you were unable to control the important things in your life?
3. In the last month, how often have you felt nervous and stressed?
4. In the last month, how often have you felt confident about your ability to handle your personal problems?
5. In the last month, how often have you felt that things were going your way?
6. In the last month, how often have you found that you could not cope with all the things that you had to do?
7. In the last month, how often have you been able to control irritations in your life?
8. In the last month, how often have you felt that you were on top of things?
9. In the last month, how often have you been angered because of things that happened that were outside of your control?
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?
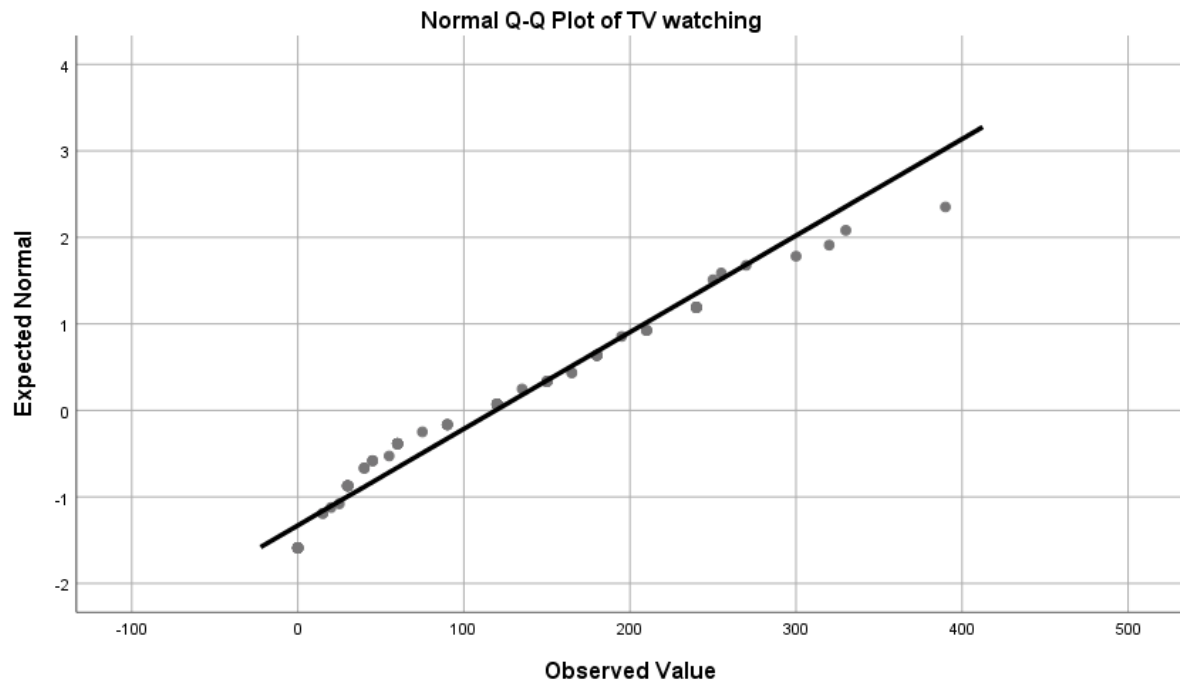
Appendix C: Cronbach's Alpha for PSS
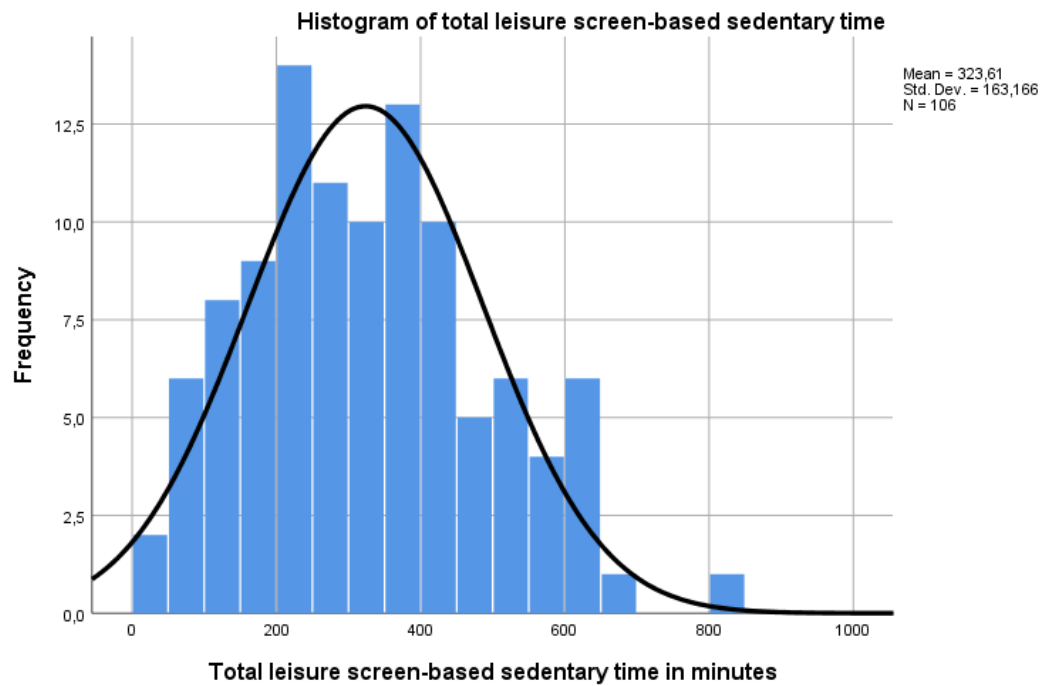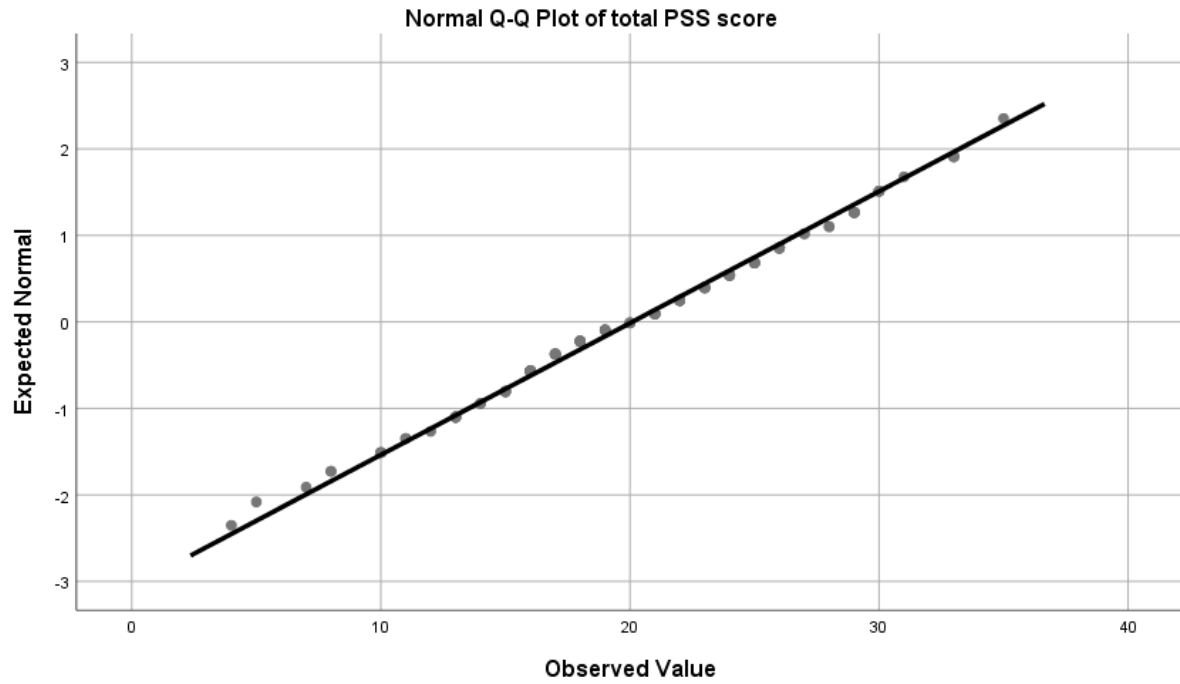
Cronbach's Alpha	N of Items
.86	10

Appendix D: Testing the Assumption of Normality

Tests of Normality
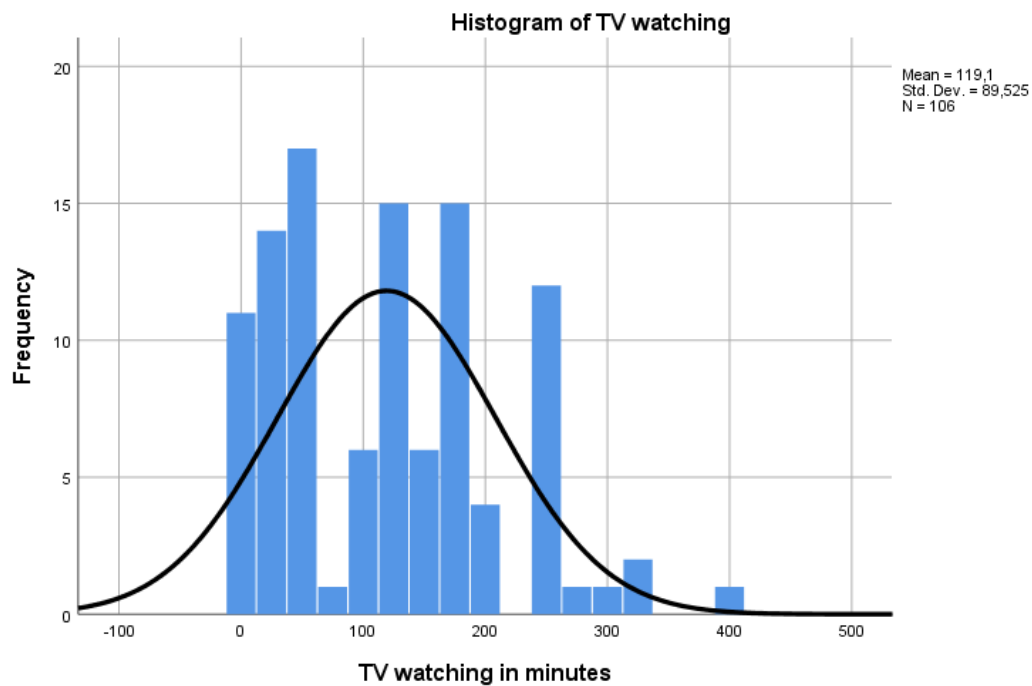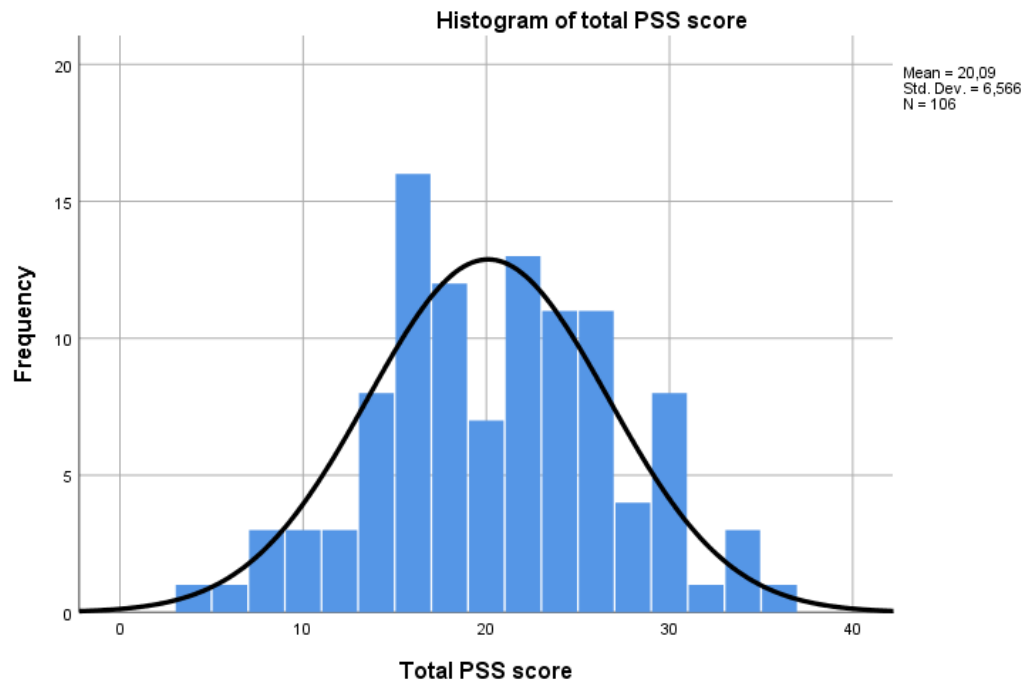
	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Screen-based sedentary behaviour time	0.07	106	.200	0.98	106	.195
TV watching	0.14	106	.000	0.94	106	.000
Scrolling through social media	0.22	106	.000	0.88	106	.000
Stress	0.07	106	.200	0.99	106	.684

Normal Q-Q Plot of total leisure screen-based sedentary time

Normal Q-Q Plot of TV watching

Normal Q-Q Plot of scrolling through social media

Normal Q-Q Plot of total PSS score

Histogram of total leisure screen-based sedentary time

Mean = 323,61
Std. Dev. = 163,166
N = 106

Histogram of TV watching

Mean = 119,1
Std. Dev. = 89,525
N = 106

TV watching in minutes

Histogram of scrolling through social media

Mean = 70,36
Std. Dev. = 56,33
N = 106

Scrolling through social media in minutes

Histogram of total PSS score

Mean = 20,09
Std. Dev. = 6,566
N = 106

Appendix E: Testing the Assumption of Homogeneity of Variance

Levene's Test of Equality of Error Variances

Dependent variable: stress	Levene Statistic	df1	df2	Sig.
Screen-based sedentary time	1.48	22	48	.126
TV watching	0.69	12	80	.760
Scrolling through social media	1.35	14	82	.198

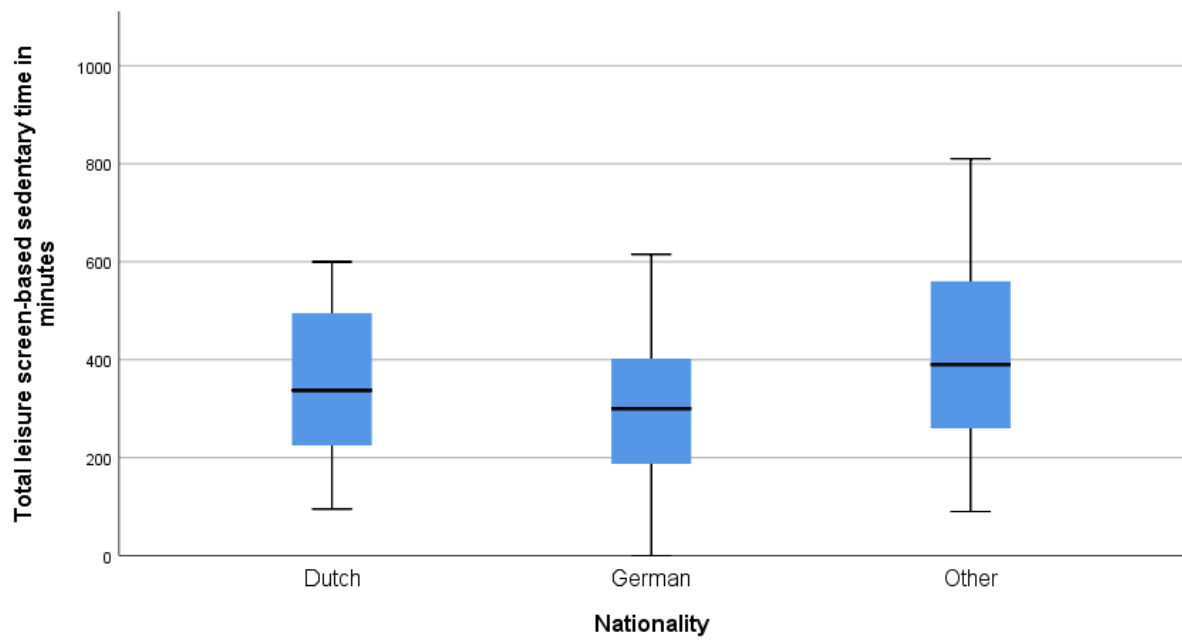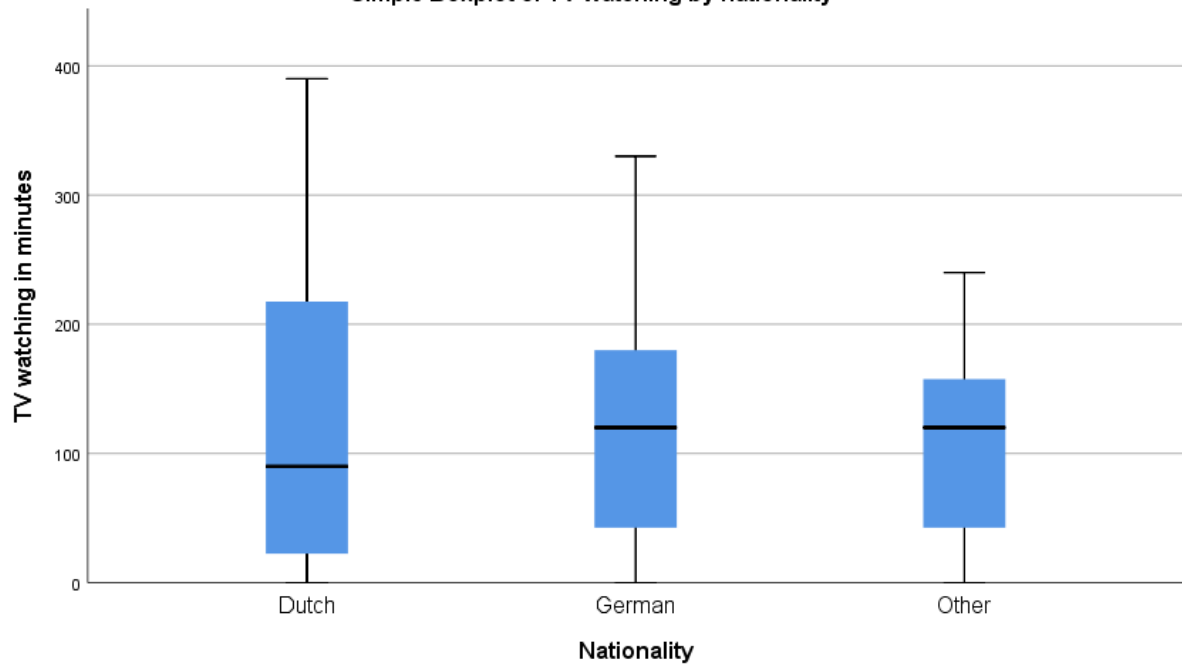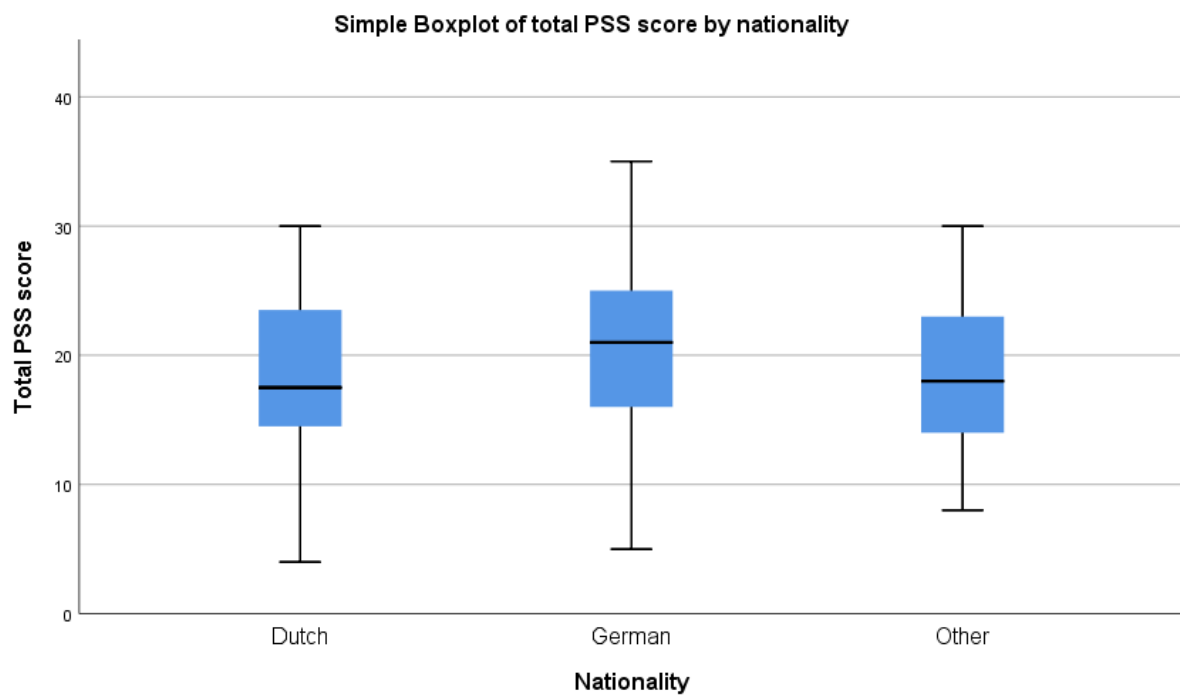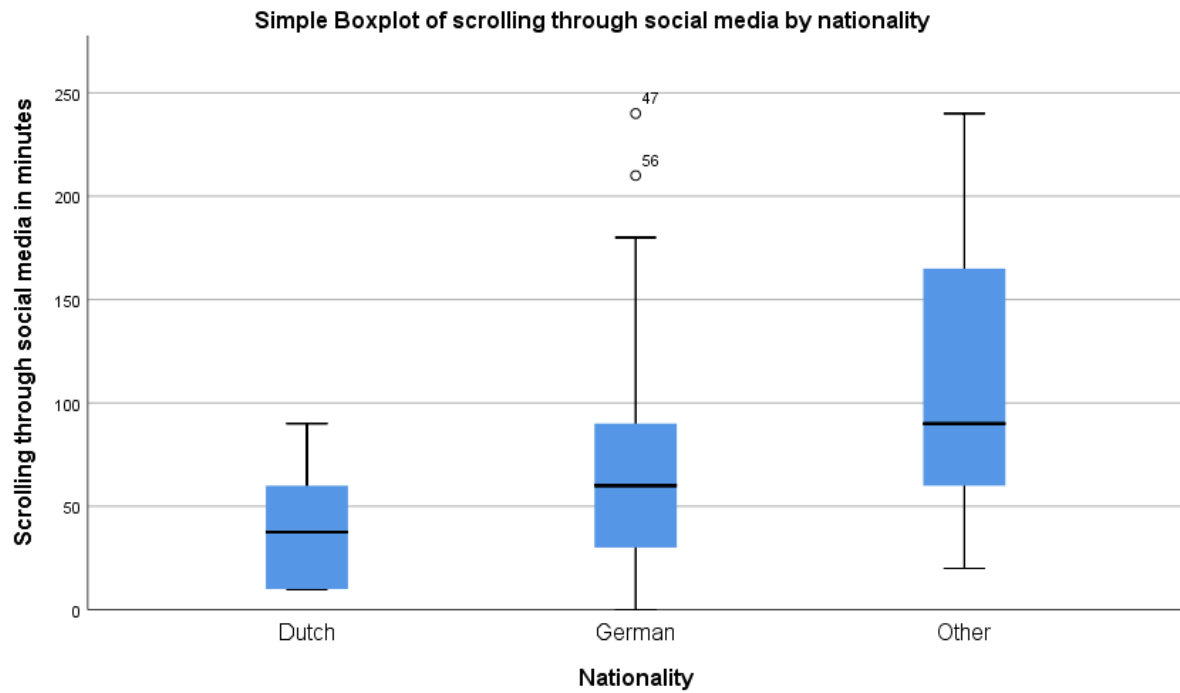**Appendix F: Testing the Assumption of Multicollinearity**

Simple Boxplot of total leisure screen-based sedentary time by gender

Simple Boxplot of TV watching by gender

Simple Boxplot of scrolling through social media by gender

Simple Boxplot of total PSS score by gender

Simple Boxplot of total leisure screen-based sedentary time by age

Simple Boxplot of TV watching by age

Simple Boxplot of scrolling through social media by age

Simple Boxplot of total PSS score by age
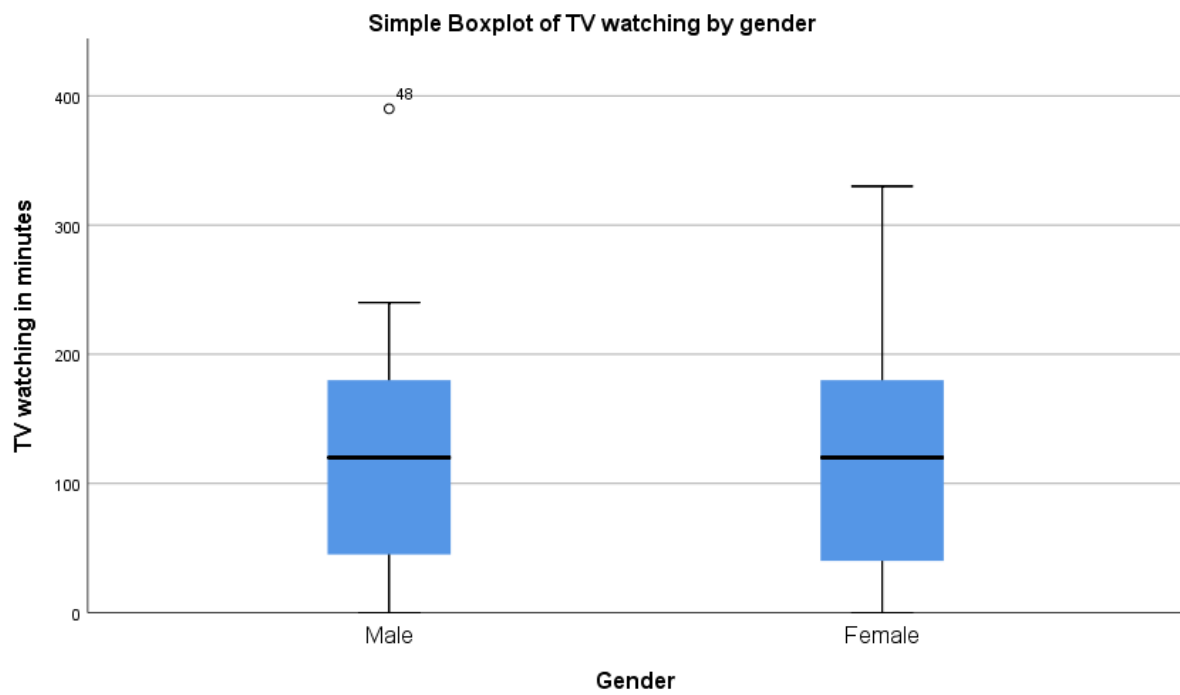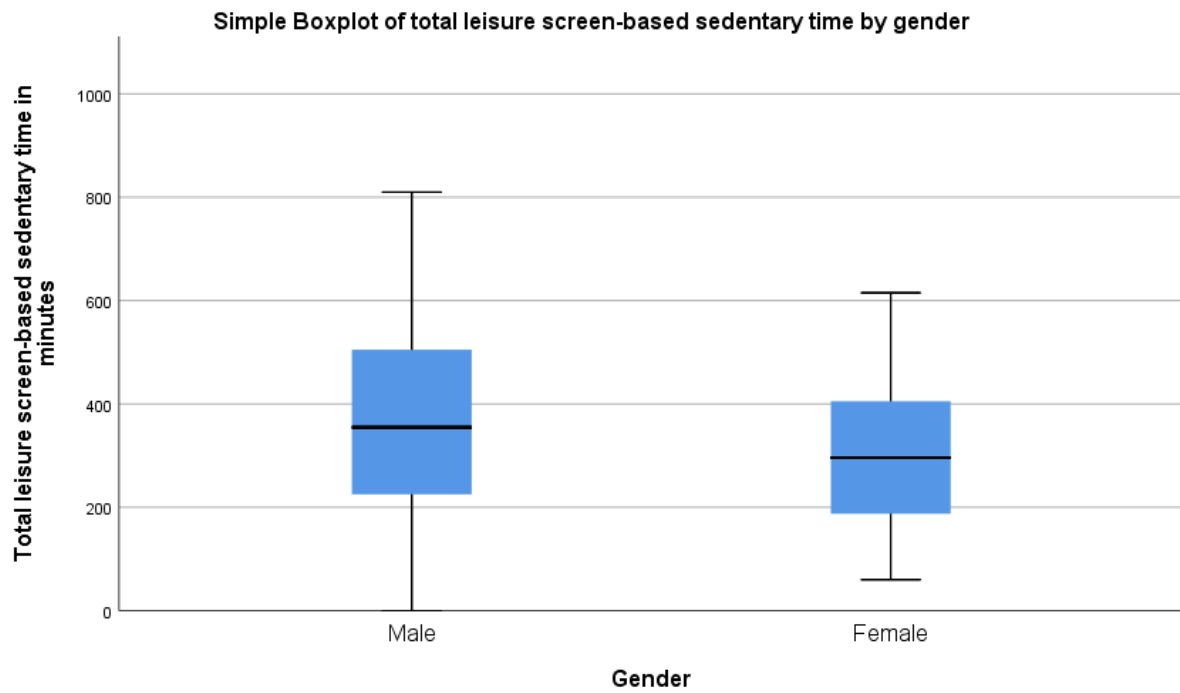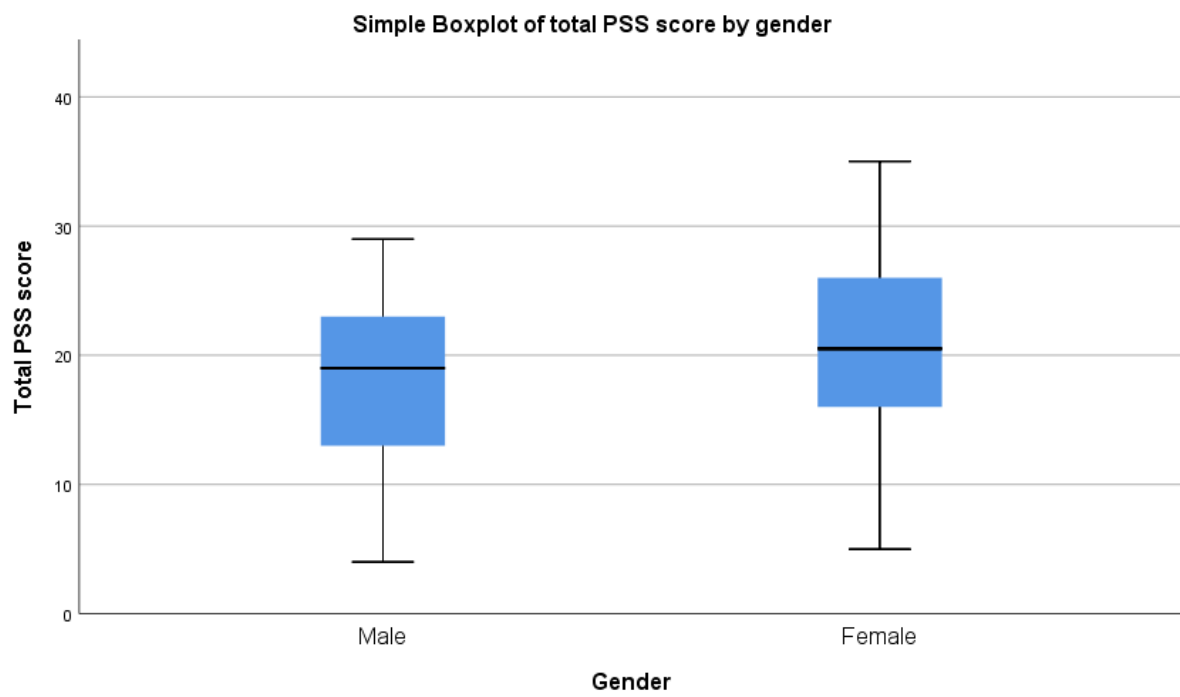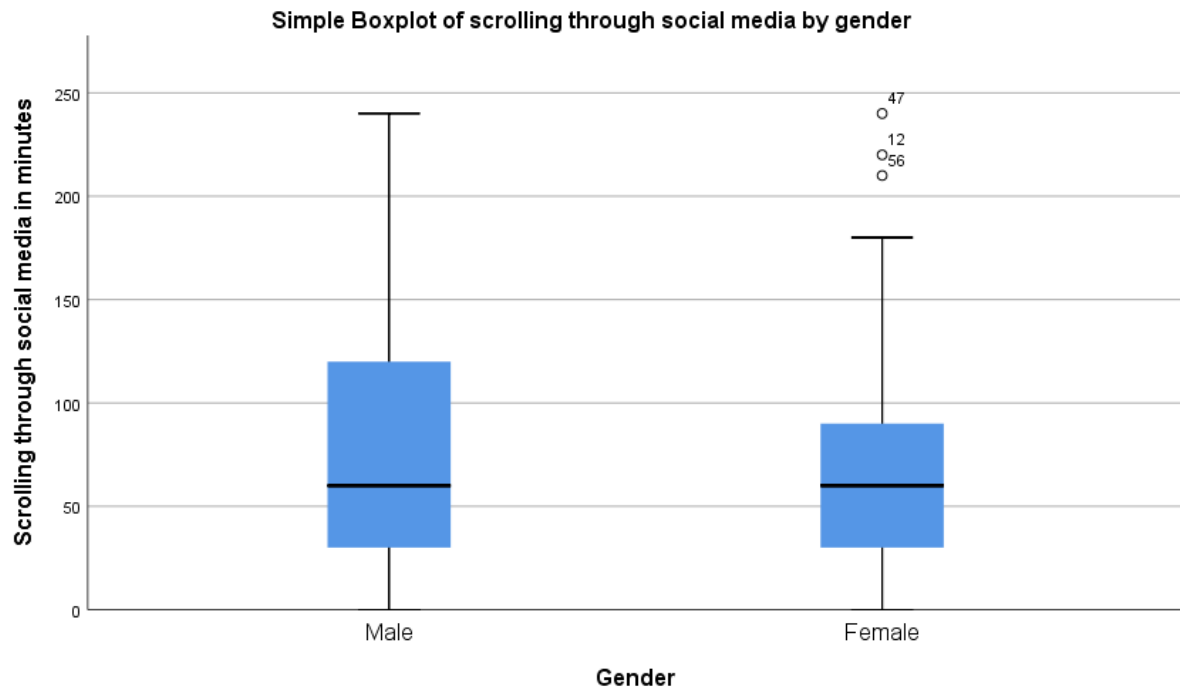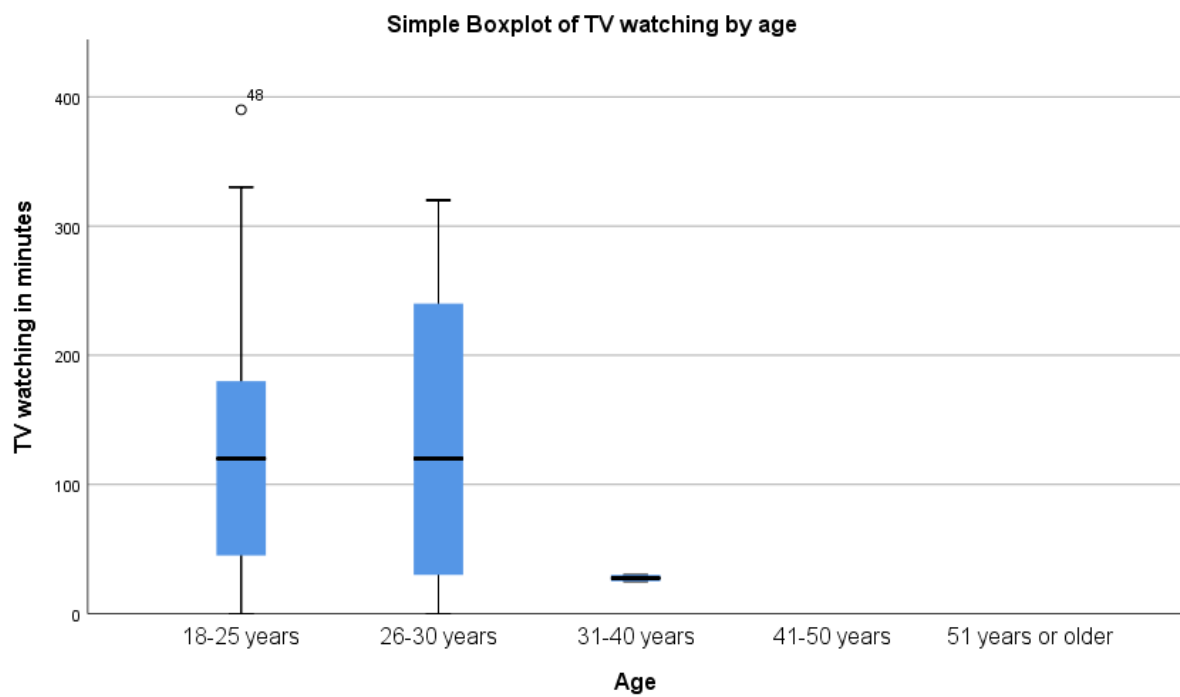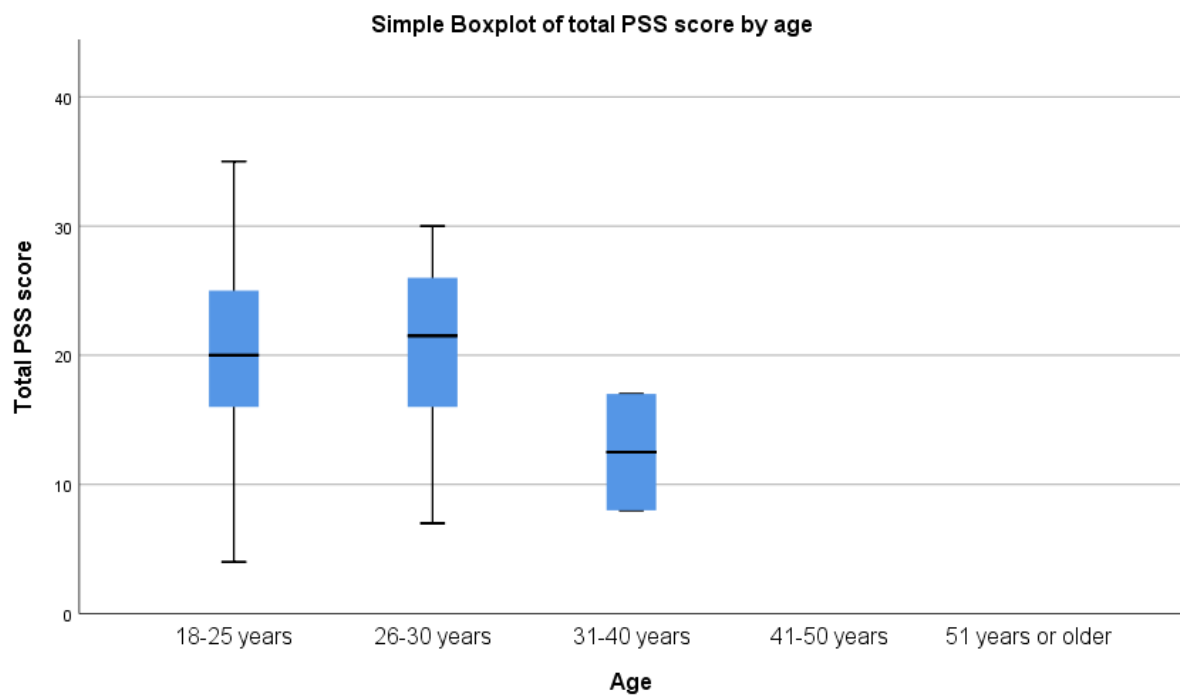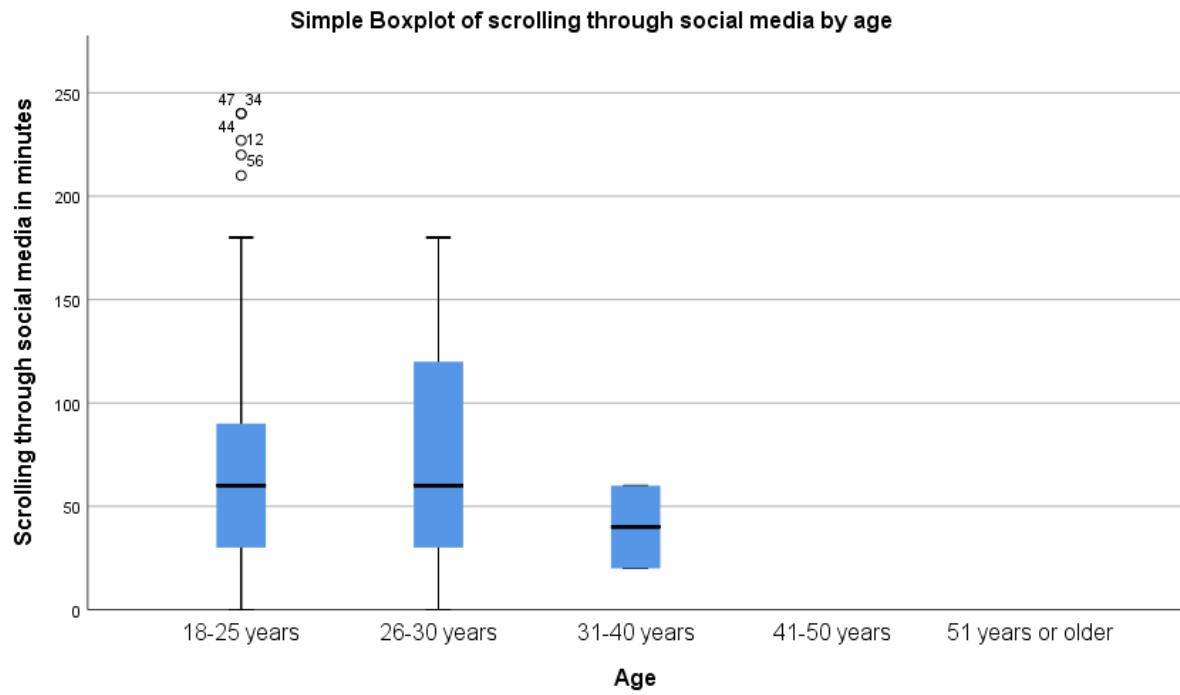
**Simple Boxplot of total leisure screen-based sedentary time by nationality**

Simple Boxplot of TV watching by nationality

Simple Boxplot of scrolling through social media by nationality
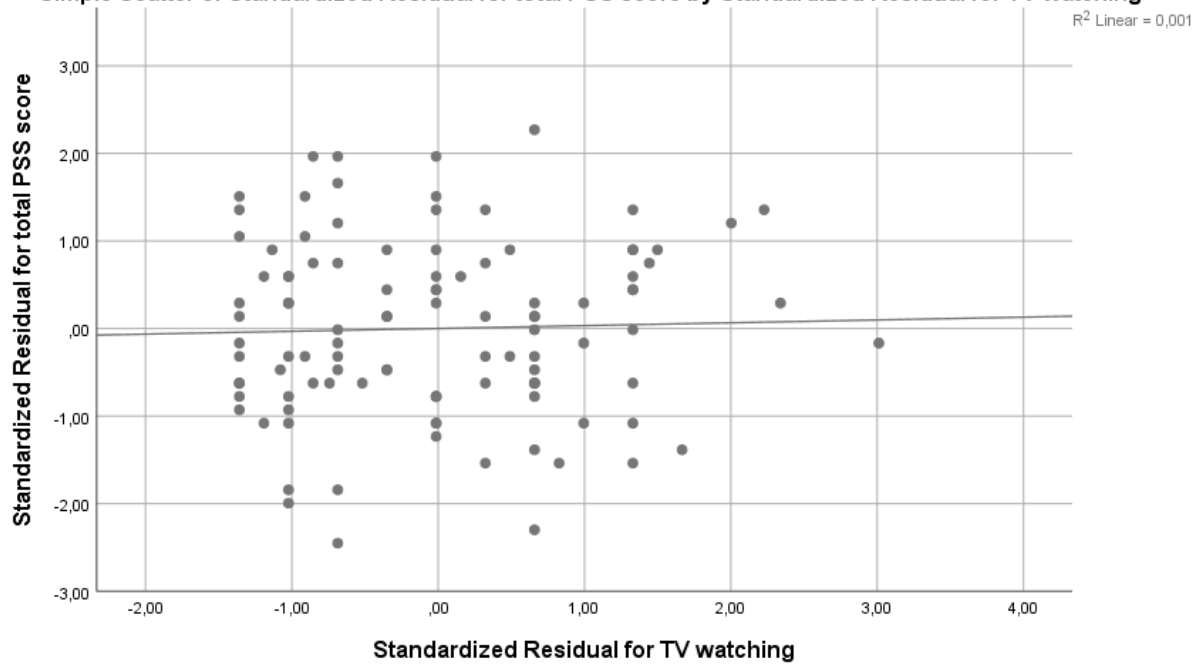

Simple Boxplot of total PSS score by nationality

Appendix G: Testing the Assumption of Linearity

Simple Scatter of Standardized Residual for total PSS score by Standardized Residual for total leisure screen-based sedentary time
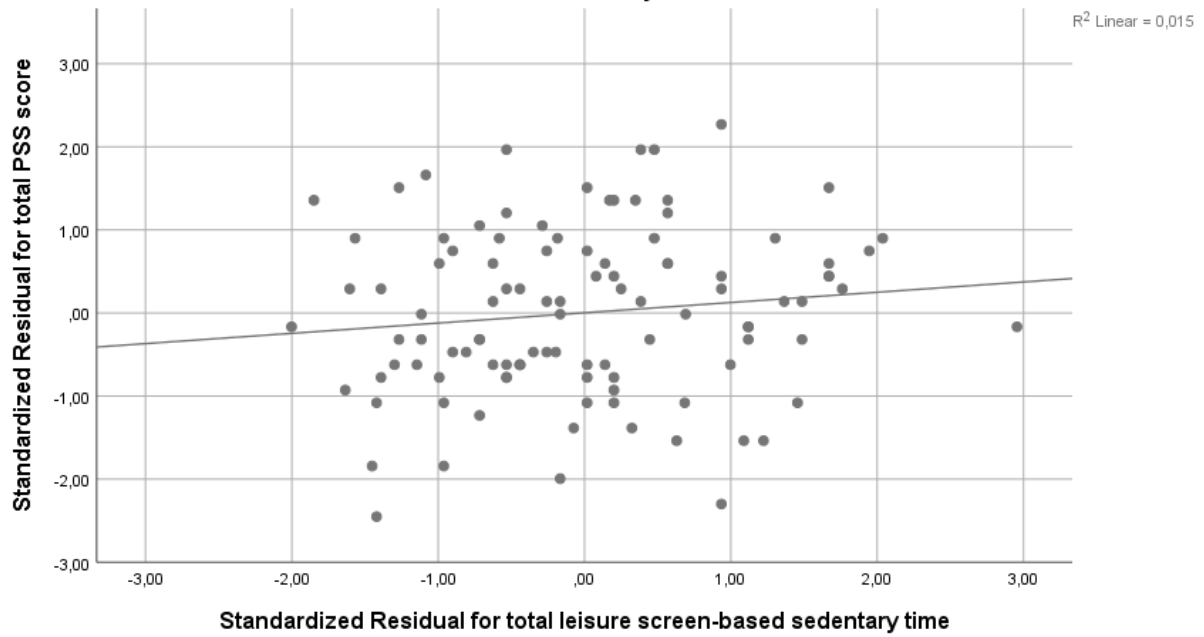
Simple Scatter of Standardized Residual for total PSS score by Standardized Residual for TV watching

Simple Scatter of Standardized Residual for total PSS score by Standardized Residual for scrolling through social media