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Research Question

To what extent does sleep quality mediate the relationship between social media use
before bedtime and symptoms of depression among 18-30 year old people?

Abstract

Using social media while laying in bed before sleeping can influence the sleep quality and depressive symptoms of 18-30 year old young adults. For example, cyber-mobbing is commonly present on social media. All popular social medias are considered (Facebook, Snapchat, Instagram etc.). It is hypothesized, that there is an effect of social media usage on depressive symptoms, with sleep quality involved as a mediator. To test this, the Pennsylvania Sleep Quality Index (PSQI) for measuring sleep quality and the Patient Health questionnaire-9 (PHQ-9) for measuring depressive symptoms is used.

In total, the sample consists of 78 people which is sufficient according to the G-Power analysis. Further, all people are between 18-30 years old, and are mainly from Germany and the Netherlands. The data is measured with simple and multiple linear regression analysis, and the Sobel-Test. Moreover, the research of Baron & Kenny (1986) is considered when evaluating if sleep quality mediates the relationship. Results show that social media usage before bedtime influences both sleep quality and depressive symptoms, and sleep quality influences depressive symptoms. However, sleep quality mediates the relationship between social media usage and depressive symptoms only partly. Although other researchers have found a significant effect in this relationship with slightly changed variables, the current study cannot confirm this. For example, Ho et al. (2021) find a relationship between Facebook-addicted young adults from Vietnam, with sleep quality mediating this relationship. Therefore, the variables 'addiction' and 'nationality' might be crucial to investigate further.

However, the current study has some limitations which have to be considered when evaluating the generalization. For example, there is a high drop-out rate of 171 people which are excluded due to several reasons, like not finishing the questionnaire or not agreeing with the informed consent.

Introduction

The trend of using a mobile device to use the internet increased over the past years. Specifically, 6.2 billion people were using a mobile device like a Smartphone on a regular basis in the year 2019 (Statista Search Department (2022). One of the most common functions of a smartphone is the usage of social media, with over 60% of young adults using social media on their mobile device (Hysing et al., 2015). Even though social media has many benefits like the facilitation of social interaction, many authors mention probable mental

health problems linked to social media, especially among young adults (Andreassen et al., 2016; Kross et al., 2013; Naslund et al., 2020).

Using social media extensively can possibly increase the likelihood of an addiction, which can result in serious harms in an individual. As there are many problems associated with an addiction, people with an addiction are more likely to be prone to mental health issues. In general, these findings are supported by Osatuyi & Turel (2018), who find that teenagers are more likely to develop a social media addiction than young adults, and report sleep problems simultaneously, linked to social media. This is due to the fact, that adults are more likely to regulate the social media usage than teenagers (Osatuyi & Turel, 2018).

Social media

Since the year 2000, social media usage increased by nearly 600% (Zolkepli & Kamarulzaman, 2015). The potential of social media is therefore high, and it is expected that the number of users will increase in the next years (Zolkepli & Kamarulzaman, 2015). According to Statista (2022), the number of social media users is at 4.59 billion people and expected to rise to 5.85 billion until 2027. To understand which factors are contributing to the high amount of social media usage and to identify possible risks, social media has to be defined, and similarities are mentioned. As there are different social media platforms, and each has a different intent for the user, definitions vary. It is dependent which social media platforms are considered.

Social media is further expected to develop highly within the next 20 years, and to have a huge impact on behaviours in the future, and on well-being (Carr & Hayes, 2015). For example, Kross et al. (2015) identifies that social media can increase well-being because interaction with others is possible, without being physically present, and at different times of the day. Next to that, analysing behaviours on social media led to the conclusion, that people who can hide behind their anonymity on social media are more likely to exhibit cyber-mobbing, than when talking to a person in real life (McCrae et al., 2017).

The most general definition is one by Khan et al. (2014). They describe social media as web tools where social interactions are the main intent. This is a rather general description including all social media. Ahmed et al. (2019) distinguishes social medias between knowledge-sharing websites where discussions are the main intent, and media-sharing websites, like photos. This distinction means that they agree with Khan et al. (2014) in regard

to the social interaction, as both knowledge-sharing and media-sharing websites are facilitating interactions with others.

One aim of social media is, to facilitate sharing media among users. Further the focus of social media is, to interact with different users by exchanging digital content (Carr & Hayes, 2015; Naslund et al., 2020). This includes photos, videos, information, and messages (Ahmed et al., 2019). As an example, on the application 'Instagram', a person can show what they are currently doing by posting a photo either privately, or publicly available to all people.

Besides media-shared content, there is the possibility to exchange texts with different intents. Therefore, the second aim of social media is to share knowledge among each other (Ahmed et al., 2019). Many users use those social media to create awareness, spread knowledge about different themes, or discuss certain events happening in the world (Kane et al., 2014). Often, a comment section is present, which facilitates this discussion. According to Kane et al. (2014), this comment section is present in order to discuss topics with each other with other people, as well as the owner of the content. Lastly, there is also the possibility to discuss things privately without the possibility of third parties to read this chat.

Both knowledge-sharing websites, and media-sharing websites, are linked to risks regarding mental health and well-being, like depressive symptoms, a decreased sleep quality or anxiety (Andreassen et al., 2016; Kross et al., 2013; Naslund et al., 2020). This is the reason why both types, namely knowledge sharing and media-sharing websites, are taken into consideration. The applications 'Facebook' and Twitter' are, due to the popularity, representative for knowledge-sharing websites, as discussions are the main intent (Andreassen et al., 2016). 'Youtube', 'Instagram', 'Snapchat', and 'TikTok' are all examples of media-sharing websites. According to Anderson & Jiang, 2018, these are also the social media websites with the most impact. Especially 'TikTok' increased in popularity during the COVID-crisis and was the most downloaded App in 2020 (Li et al., 2021).

One reason why people use social media extensively is, that people feel entertained. It might happen, that individuals forget the time and gain less sleep at night, when browsing on social media until the middle of the night (Wong et al., 2020). Another reason might be, that an individual is still in excitement after browsing on social media, and therefore falling asleep might take longer than usual (Wong et al., 2020).

Social media usage and Sleep Quality

Social media can have an influence on the sleep quality of an individual. It is a frequent problem, as 89% of young adults experience poor sleep quality (Adams & Kisler,

2013). The origin is multidirectional, whereas one factor might be related to social media. The question remains why social media has such an impact on falling asleep. Wong et al. (2020) state two reasons. On the one side, social media leads to psychological stimulation. This means, that seeing photos, videos or discussions before bedtime has a high level of excitement, and the entertainment factor is present. On the other side, the light of the smartphone itself has an impact on hormones in the body, leading to poor subjective sleep quality (Wong et al., 2020).

According to Zhi Zu (2015), people using social media right before bedtime report poor sleep quality. Due to the excitement level discussed above, the individual might still process the photos and videos consciously and unconsciously and is therefore not able to fall asleep (Wong et al., 2020). As sleep quality is subjective, each individual needs different conditions under which one sleeps in the best way. For example, some need a dark room, whereas others can sleep better when it is not dark. Therefore, some people do not process entertaining images in their mind long and can fall asleep faster, whereas others cannot (Zhi Zu, 2015). Still, some researchers identify common factors and explanations why a high number of hours of social media usage contributes to a poor reported sleep quality, which will be discussed in the following (Wong et al., 2020).

Subjective sleep quality is influenced by different means. On the one side, individuals which report falling asleep fast, report a better experienced sleep quality than when taking longer to fall asleep, whereas on the other side laying in bed while not being able to sleep is bad for the reported sleep quality (Wong et al., 2020). A reason for having troubles falling asleep is the time spent on social media right before bedtime. This means, laying in bed, but not trying to sleep, so being busy with other things, such as reading a book or surfing on social media. This results in delaying the bedtime and shortening the actual amount an individual is sleeping (Wong et al., 2020). Another factor which has to be mentioned when defining sleep quality is the resulting daytime sleepiness (Moo-Estrella et al., 2015). Due to this daytime sleepiness, which results in not being able to be productive on the day, individuals can create depressive symptoms (Moo-Estrella et al., 2015).

Social media usage and depressive symptoms

As already mentioned above, social media websites have an influence on the mental health of an individual (Adam & Kisler, 2013). Bhandari et al. (2017) found a negative correlation between social media usage and depressive symptoms, meaning that high social media usage over the day might increase depressive symptoms. McCrae et al. (2017) indicate

that this is not always the case, and that the relationship between social media usage and depressive symptoms relies on the individual level, meaning that the personality might either increase or decrease depressive symptoms due to social media. As an example, social media might be a rather harsh environment, where cyber mobbing is prevalent (McCrae et al., 2017). This might lead some people to experience depressive symptoms because they are not able to cope with this, whilst others seem to not care. This is supported by Kross et al. (2013), who indicate that the development of depressive symptoms relies highly on the individual level.

Next to that, using social media frequently usage increases the loneliness level, as individuals spend more time on the smartphone than with their social environment (McCrae et al., 2017). A high loneliness level is positively correlated with depressive symptoms (McCrae et al., 2017). Next to that, McCrae et al. (2017) also mention, that a perfectionistic image is postulated by social media which many people try to follow, whereas the strive to achieve this perfect lifestyle can increase the likelihood of depressive symptoms. As an example, very attractive people are showing their body on Instagram, and every difference between a young adult and this perfect image can a result in low self-esteem and depressive symptoms through constant comparison (McCrae et al., 2017).

Kross et al. (2013) also indicated, that even though social media might increase the likelihood of depressive symptoms, there are some benefits. It facilitates social interaction, and the loneliness level decreases by interacting with others. Here, contradictory results are mentioned, as the feeling of being lonely is very subjective. Therefore, social media can both increase and decrease depressive symptoms. Henceforth, it might be that there is an individual component, dependent if an individual has more benefits or disadvantages of using social media (Beyens et al., 2020). As already mentioned above, the time spent on social media is also an important factor to consider. This would mean that the relationship is person specific, although a certain pattern might be identified, for example if there is a relationship on the exact time of time spent on social media on depressive symptoms.

Previous findings

Tandon et al. (2020) provide another reason why social media affects the sleep of an individual. For example, the lack of self-regulation in the own behaviour. Due to the lack of self-regulation, people spend more time on social media. As there is no certain time when individuals go to sleep and can spend as much time as they want on social media, it becomes evident that they cannot resist the entertainment. Specifically, people with a reported spend

time of two or more hours on social media before bedtime are more likely to experience poor sleep quality (Zhi Zu, 2015).

Somewhat contradictory, Tavernier & Willoughby (2014) identified, that the relationship is bidirectional, meaning that poor sleep quality increases social media usage, and high social media usage leads to poor sleep quality. Depressive symptoms might be strengthened by reporting poor sleep quality.

The relationship between depressive symptoms, social media usage and sleep quality

The effect of social media on both depressive symptoms and sleep quality has been assessed by previous researchers (Beyens et al., 2020; Kross et al., 2013). Therefore, it must be questioned if these three constructs are related to each other and how. It appears that all three influence each other to some extent, as can be party seen in the bidirectional relationship between sleep quality and social media usage (Tavernier & Willoughby, 2014). Some researchers also investigate this relationship in a slightly different way, with smartphone usage in general and not with social media.

This above-mentioned relationship, with sleep quality as a mediator, is negatively (Demirci et al., 2015). This means, that using the smartphone before bedtime decreases the subjective sleep quality and increases symptoms of depression. This is also supported by Wong et al. (2020), who indicated that the light of the smartphone has an impact on the hormones in the body, leading to poor subjective sleep quality.

Further, as already mentioned above, social media has an influence on depressive symptoms in an individual (Kross et al., 2013). As contradictive results are found by different researchers about the relationship between social media usage and depressive symptoms, this is something to explore in further detail. As poor sleep quality also might influence the likelihood of depressive symptoms negatively, and social media usage especially before bedtime influences the sleep quality, a relationship might be possible (Raniti et al., 2017).

Research Question

Recently, the relationship between depression, sleep quality and social media in general is investigated. Whilst the findings of sleep quality focus on both social media usage in general and before bedtime, scientists researching depressive symptoms shift the focus on the consequences of social media usage in general, or how much an individual spends on social media and how it is linked to depressive symptoms. (Beyens et al., 2020; Kross et al., 2013).

The above mentioned findings lead to the following research question; '*To what extent does sleep quality mediate the relationship between social media use before bedtime and symptoms of depression among 18-30 year old people?*'. Here, the most popular social media according to the definition of knowledge-based and media-based are taken into consideration. Namely, these are 'YouTube', 'Instagram', 'Snapchat', 'Facebook', and 'Twitter'. Further, as there is little research about the app 'TikTok', which increased in popularity over the past years, it is also considered. As research indicated that social media might increase depressive symptoms, or decrease depressive symptoms, it is expected that using social media before sleeping also has an influence on depressive symptoms.

Due to previous research on social media usage before bedtime on the sleep quality, it is expected that time spent on social media before going to bed has an influence on the sleep quality of an individual, which then has an influence on depressive symptoms. In line with the previously mentioned findings by different authors, the following hypotheses for the research question can be formulated;

H_1: *There is a positive relation between social media use before bed and depressive symptoms.*

H_2: *There is a positive relation between social media use before bed and subjective sleep quality.*

H_3: *There is a positive relation between subjective sleep quality and depressive symptoms.*

H_4: *Sleep quality mediates the relation between time spent on social media before bed and depressive symptoms.*

Methods

Participants

In order to investigate how many participants are needed in order to be statistically sufficient, a G*Power analysis is conducted (Faul et al., 2007). According to this, a minimum sample size of 81 participants is required. To participate, the participant has to be between 18-30 years old, and use social media. In total, 252 people participated in this study. After deleting incomplete responses, people who are under 18 or over 30, and people who do not answer the attention check correctly, the study contains a sample of 78 participants between 18 and 30 of age. The sample consists of 48 females, 28 males, and two participants who identify as 'Other', all with sufficient understanding of English. The mean age of the

participants is 22.4. In total, six participants are Dutch, 56 are German and 16 are from another nationality. All participants are recruited by opportunity/convenience sampling.

Materials

Social media

Two methods exist in order to measure social media usage. Firstly, it is possible to measure the screen time by looking into the settings of an electronical device, which is proven to be more accurate (Przybylski & Weinstein, 2017). Secondly, it is possible to establish a self-report questionnaire and let the participants estimate the amount spent on social media (Buysse et al., 2010). Generally, this is easier as no instructions are needed on how to find social media (Buysse et al., 2010). Considering this, participants have to estimate, for the past two weeks, the average amount of time they have spent every day on social media while laying in bed before falling asleep (Appendix A).

Depressive symptoms

The Patient Health questionnaire-9 (PHQ-9) is a brief questionnaire measuring depressive symptoms (Kroenke et al., 2001). For the PHQ-9, a Cronbach's alpha of 0.81 is found, whereas the cut-off point is 0.7. This means, that the PHQ-9 is sufficient regarding its reliability, and also validity (Anderson et al., 2011; Hammash et al., 2013).

It is a self-report questionnaire consisting of nine items in total (Appendix B). Its usefulness in different settings and to different populations has been proven (Anderson et al., 2011; Hammash et al., 2013; Kroenke et al., 2010). To measure the severity of depressive symptoms, the participants must answer to what extent they were bothered by different symptoms of depression in the last two weeks by answering nine questions on a four-point Likert scale, varying from 'Not at all', 'Several days', 'More than half of the days' and 'Nearly every day' (Kroenke et al., 2010).

The researcher adds up the points a participant receives, whereas 'Not at all' represents zero points, and 'Nearly every day' three points. Therefore, the maximum points a participant can achieve are 27 points. The cut-off points for classifying a participant in different categories are zero, five, 10, 15, and 20, representing none, mild, moderate, moderately severe, and severe levels of depressive symptoms. Further, it measures the depressive symptoms according to the DSM IV.

Sleep quality

Sleep quality is measured by the Pennsylvania Sleep Quality Index (PSQI), which is a self-report questionnaire measuring the subjective sleep quality of an individual (Buysse et al., 1989). For the PSQI, a Cronbach's alpha of 0.88 is found, whereas the cut-off point is 0.7. This means, that the PSQI is sufficient regarding reliability, but also the validity is high (Beck et al., 2004; Buysse et al., 1989). The sleep quality is measured by seven items that cover the participant's last month (Appendix C). The PSQI measures sleep quality by asking questions about seven constructs, namely of the sleep latency (how long it takes to fall asleep), sleep duration, sleep efficiency (hours slept/hours in bed x 100%), sleep disturbance, subjective sleep, use of sleep medication, and daytime dysfunction (Buysse et al., 1991)

The first part of the questionnaire consists of four numeric items, therefore using a number as an answer when they usually wake up, or when one tries to sleep (Ko, 2020), (Appendix C). The second part consists of three items. These three questions are statements, with whom the participant must indicate what they agree the most with. Classically, this is a four-point Likert scale ranging from 'Not during the past month', 'less than once a week', 'once or twice a week' and 'three or more times a week'. Each person can score a maximum of 21 points, which is considered as bad sleep quality. Therefore, when the score is higher, the individual experiences worse sleep quality.

In order to evaluate if an individual experiences poor sleep quality, a cut-off point has to be introduced by which one can say, that it is considered as poor sleep quality. In the study of Huang & Zhu (2020), the cut-off point of >16 as an indicator for bad sleep quality leading to depressive symptoms is mentioned, meaning that there is a relationship between poor sleep quality and depressive symptoms. Next to that, Shahid et al. (2012) introduce the cut-off point of 5 for bad sleep quality. Lastly, in the questionnaire are normally questions included, which must be answered by a roommate. As this would lead to excluding many participants, and the questions do not add up to the overall score, these questions are excluded.

As both questionnaires are part of a bigger questionnaire in a collaboration with other researchers, the questions are randomized with all others, so no clear pattern is visible. One attention check question is included randomly in the middle of the questionnaire. Failing this attention check leads to deletion of the data of this participant.

Procedure

This study is accepted by the BMS Ethics Committee (EC) of the University of Twente in March 2022, with the approval number 220244. The participants are recruited by all researchers with opportunity/convenience sampling. Next to that, the study was spread via

WhatsApp, Instagram, Facebook and LinkedIn. Further, the study is published on a website called 'Sona', where mainly psychology students from the University of Twente can participate. The participants of the study are informed about the purpose, content, and data acquisition. They are informed, that the data is treated confidential, and all data is anonymized. After providing active informed consent about this information, the guidelines and procedure of this study is provided, demographic questions like the gender, age and nationality are asked. Lastly, the question of measuring social media usage before bedtime is asked (Appendix A).

As other researchers are involved in this study as well measuring different constructs, the participant must answer those questions as well, but this will not be described further. As all questions are randomized with the questions of the other researchers, questions of both constructs of depressive symptoms and subjective sleep quality were answered randomly (Appendix B, Appendix C). At the end of the questionnaire the participant is debriefed and thanked for participation, and contact details of all researchers are provided. It takes approximately 45-60 minutes to complete the survey.

Data Analysis

To analyse the data, the software 'SPSS.27' is used (IBM Corp., 2019). As the first step, all answers which are incomplete are excluded from the further analysis. Further, extreme answers are also excluded to filter out distortion of analysis. Every data is excluded when the attention answer is answered incorrectly. Further, a question is asked if people check social media before going to sleep with a dummy variable, so have to answer either 'yes' or 'no', and how long they are spending time on social media as a numeric variable. If a participant answers with 'no', so does not check social media before going to bed, the data will be excluded. Statistical analysis like means and standard deviations are calculated to see if any irregularities are present. Next to that, the data will be tested according to the four assumptions, namely linearity, independence, equality of variance and normality. For normality, a histogram is created to investigate if it is bell-shaped and symmetric. For all other assumptions, a scatter plot will be created and checked for irregularities.

The first part, after excluding data is, to conduct basic statistical analysis to describe the sample. For this, the nationality, age and gender are described. Additionally, descriptive statistics in comparison to the cut-off scores are described. The items from the PHQ-9 measuring the construct 'depressive symptoms' is the dependent, numeric variable, whereas social media usage before bedtime in the format hours.minutes is the numeric, independent

variable. Further, as 'sleep quality' is a hypothesized to have a mediating effect in this relationship, the variable 'sleep quality' from the PSQI questionnaire will function as a dependent variable for social media before bedtime and as an independent variable for the effect on depressive symptoms simultaneously. Therefore, the following steps need to be taken, ordered per hypothesis.

The first hypothesis measures the relationship between social media usage and depressive symptoms, whereas social media usage is the independent variable. As both variables are numeric variables, a simple linear regression analysis is conducted. The second hypothesis is for measuring the relationship between social media usage before bedtime, and sleep quality. Again, both variables are numeric, and a simple linear regression analysis is used. The third hypothesis is about the relationship between sleep quality and depressive symptoms. For this, a simple linear regression analysis is conducted. All three simple linear regressions for the first three hypotheses are also called 'Pearson's correlation'.

Lastly, the fourth hypothesis states, that sleep quality mediates the relationship between social media usage and depressive symptoms. Hence, a multiple linear regression analysis for mediation is conducted, with the variables social media usage before bedtime on depressive symptoms, mediated by sleep quality. As the last point, the Sobel-test for mediation is conducted (Sobel, 1986). The hypotheses are built upon the approach of Baron & Kenny (1986). According to them, if the first three hypotheses are accepted, partial mediation is achieved. However, only if the fourth hypothesis is also accepted, full mediation is reached.

Results

Before testing the hypotheses, the three variables will be compared to the cut-off scores mentioned in the materials section.

Table 1

Descriptives sleep quality and social media usage before bedtime

	M	SD	Min score	Max score	N < Cut-off score	N > Cut-off score
Social media use before bedtime	.61	.61	0	3	5	70
Sleep quality	4.7	2.5	0	11	25	45

Note: For social media use before bedtime, the cut-off score is two, whereas for sleep quality, the cut-off score is five. Each number represents one participant.

Firstly, spending two hours or more on social media before bedtime is considered as problematic (Zhi Zu, 2015). A minimum of zero, a maximum of three, with a mean of .61 (*sd=* .61) is found, representing 61 minutes. This means, that the average time a person spends on social media while laying in bed before sleeping, is approximately one hour, whereas two hours are considered as increasing the likelihood of mental illnesses (Zhi, Zu, 2015). In this study, five people are over this cut-off score of two, whereas 70 are under the cut-off score (Table 1).

Secondly, the cut-off score of five for measuring sleep quality has been introduced by Shahid et al. (2012). Taking this into account, 25 people experience poor sleep quality (Table 2). The minimum in the sample is one, whereas the maximum is 11, with a mean of 4.7 (*sd=* 2.5). Lastly, another cut-off score of 16 introduced by Huang & Zhu (2020) for bad sleep quality leading to depressive symptoms is analysed on this sample. According to that, nobody is over the score of 16. As can be seen in Table 1, the maximum score a person has, is 11.

Table 2

Descriptives depressive symptoms

	M	SD	No DS	Mild DS	Moderate DS	Moderately severe DS	Severe DS	Min score	Max score
Depressive symptoms	6.4	4.6	40	29	10	2	1	0	24

Note: DS = Depressive symptoms. No depressive symptoms = score of 0, mild depressive symptoms <5, moderate depressive symptoms <10 etc.

Lastly, the dependent variable 'depressive symptoms' is described according to the cut-off scores zero, five, 10, 15 and 20 representing none, mild, moderate, moderately severe, and severe levels of depressive symptoms (Table 2). Taking this into account, 40 people have no depressive symptoms at all, 29 people are classified as having mild depressive symptoms and 10 people have moderate depressive symptoms (Table 2). Lastly, two people are classified as having moderate depressive symptoms, and one person has moderately severe

depressive symptoms. Summarizing, the minimum score is zero, whereas the maximum score is 24, with a mean of 6.4 (*sd*= 4.6).

Next to that, four assumptions must be analysed to proceed with the analysis. Namely, these are the independence of residuals, the equal variance of residuals, normality of residuals and linearity, tested on the dependent variable 'depressive symptoms' and on the mediator variable 'sleep quality'. In order to test the independence of residuals, the equal variance of residuals, and the linearity, a scatter plot is created in SPSS and checked for violations (Figure A, Figure B, Figure C). For the assumption of 'normality of residuals', a histogram is created and checked for a symmetric, bell-shaped curve (Figure D, Figure E). All assumptions are not violated. As all four assumptions are met, the analysis of data can be further processed and analysed.

Hypothesis 1: There is a relation between social media usage before bed and depressive symptoms

In this relationship, a significant effect has been found, *b*= 1.94, SE = 0.85, t(76) = 2.28, *p* = .025. The first hypothesis can be accepted. Therefore, when people use social media before bedtime, the depressive symptoms increase.

Hypothesis 2: There is a relation between social media use before bed and subjective sleep quality

In this relationship, a significant effect has been found, *b*= 0.95, SE = 0.46, t(75) = 2.06, *p* = .042. The second hypothesis can be accepted. Therefore, people who use social media before bed report poorer sleep quality.

Hypothesis 3: There is a relation between subjective sleep quality and depressive symptoms. A significant effect has been found *b*= 0.82, SE = 0.19, t(78) = 4.3, *p* = >.001. Therefore, the third hypothesis can be accepted.

Hypothesis 4: Sleep quality mediates the relation between time spent on social media before bed and depressive symptoms.

No significant effect has been found, b= -0.52, SE = 0.33, t(73) = -1.6, p = 0.12. The last hypothesis can be rejected, meaning that sleep quality does not mediate the relationship between social media usage before bedtime and depressive symptoms. According to the Sobel-test, no significant effect has been found, t= 1.86, p = 0.06.

Discussion

The goal of the study is, to investigate the relationship between social media usage before going to bed and mental well-being, whilst focussing on 'depressive symptoms' and 'sleep quality' as subcomponents of well-being. This goal results in the following research question: '*To what extent does sleep quality mediate the relationship between social media use before bedtime and symptoms of depression among 18-30 year old people?'.* Further, it is hypothesized that there is a relation between social media usage before bed and depressive symptoms (H_1), a relation between social media use before bed and subjective sleep quality (H_2), a relation between subjective sleep quality and depressive symptoms (H_3), and that sleep quality mediates the relation between time spent on social media before bed and depressive symptoms (H_4). Summarizing the results, the first three hypotheses can be accepted, whereas the last hypothesis cannot be accepted.

Answering the research question, sleep quality mediates the relationship between social media use before bedtime and symptoms of depression among 18-30 year old people partly, although when people spend time on social media before going to bed, the likelihood of poor sleep quality and depressive symptoms increases. This is in line with the research by Baron & Kenny (1986), as they argue that four steps must be met to have a full mediation effect. As only the first three hypotheses are met whereas the fourth is not, only partly mediation is achieved.

Possible explanation of results

The first hypothesis can be accepted, meaning that social media usage before bed as an independent variable has an influence on the depressive symptoms of an individual. Specifying, this relation is positive. In the context of the hypothesis, people who use social media before bedtime longer, are more likely to express depressive symptoms. This is in line with previously conducted research (Kross et al., 2013; McCrae et al., 2017). Reasons for this, indicated by other researchers, is for example the coping ability of an individual. According to McCrae et al. (2017) social media can be an environment where cyber mobbing might be present. Especially, it has been found in other studies that people who hide behind their

anonymity might have a lower threshold for insults than people bully others in real life, and cannot hide behind their anonymity (McCrae et al., 2017). If possible victims are able to cope with this, they are less likely to develop depressive symptoms.

This could over weigh the benefits of having a social network, and lead to depressive symptoms. Further, as indicated by Escobar-Viera et al. (2018), people who use social media actively are more likely to express depressive symptoms than people who use it passively. As people who use social media mostly actively, so posting photos and videos, more people are reached (Escobar-Viera et al., 2018). Statistically, when more people are reached, the likelihood of cyber mobbing increases, whereas this possibly increases depressive symptoms (Escobar-Viera et al., 2018.

The second hypothesis can also be accepted, meaning that there is a relation between social media usage before bedtime as an independent variable and sleep quality as a dependent variable. Specifically, the relation between these two variables is positive, meaning that higher social media usage before bedtime is associated with poorer subjective sleep quality. This can have multiple reasons. According to Wong et al. (2020), social media leads to psychological stimulation. This means, that seeing photos, videos or discussions before bedtime has a high level of excitement, and the entertainment factor is present. On the other side, the light of the smartphone itself has an impact on hormones in the body, leading to poor subjective sleep quality (Wong et al., 2020).

Further, sleep quality is very subjective and can differ on certain periods in life. For example, in stressful life events, a person has poorer sleep quality than on relaxed life events (Zhi Zu, 2015). Next to that, it is already known that people lose the sense of time when doing fun activities. If an individual perceives social media as exciting, it might be that people spend time on social media unconsciously, and therefore spend more time until the middle of the night. For example, when people are entertained, they lose track of time, and spend more time on social media whilst laying in bed than expected. As the amount of sleep is becoming lower, and the number of hours sleeping is one aspect of sleep quality, it is already a reason why the sleep quality is low when spending time on social media longer.

Further, according to Dağ & Kutlu (2017), there are several other reasons which influence the sleep quality of individual, next to social media usage. For example, the age, sex, eating habits, alcohol and tobacco use, lifestyle and family factors all influence sleep quality (Dağ & Kutlu, 2017). These factors, next to social media usage before bedtime, all can have an effect on the sleep quality. In their study, the average time spent on the Internet is three hours per day but having no effect on the sleep quality. Therefore, it might be that only

using social media before bed is influencing sleep quality, or simply using the Internet does not influence sleep quality but social media specifically does.

The third hypothesis can also be accepted, meaning that there is a relation between subjective sleep quality and depressive symptoms. Similar to the first two hypotheses, the relation is also negative, meaning that the poorer an individual's sleep quality, the higher their depressive symptoms. This is in line with other findings. Dağ & Kutlu (2017) indicate, that there is a moderate relationship between sleep quality and depressive symptoms, although it cannot clarify which variable is the cause for the other, implicating that the relationship is bi-directional. For example, Guo et al (2014). find, that people with depressive symptoms 2.5 times more likely to have poorer reported sleep quality. Further, Moo-Estrella et al (2015) clarify, that people with depressive symptoms are more likely to report daytime sleepiness, which is also considered as a sub term of sleep quality.

Although there is an effect of social media use before bed on both depressive symptoms and on sleep quality, as well as an effect of sleep quality on depressive symptoms, the last and fourth hypothesis is the only one which cannot be accepted. Meaning, that sleep quality has no, or taking the research by Baron & Kenny (1986) into account, a partial mediating effect on the relation between social media use before bed and depressive symptoms. As the first three hypotheses are accepted, there is a partial mediating effect. As Ho et al. (2021) comes to a different conclusion, namely that sleep quality indeed has a mediating effect from Facebook on depressive symptoms, this study has to be described and compared.

In the study by Ho et al. (2021) the authors indicate that when people use social media longer, the depressive symptoms increase, whereas sleep quality has a mediating effect in this relationship. Here, the shift of focus lies on Facebook. Possible reasons for this are, that individuals report poorer sleep quality regarding a changed circadian rhythm of sleep due to a Facebook addiction. Further, the sample consists of mainly Vietnamese, Facebook-addicted young adults. As the hypotheses in the study by Ho et al. (2021) are very similar to the current study, but different results are found, explanations must be given.

The study of Ho et al. (2021) takes place with Facebook-addicted young adults. Therefore, there are two variables which are not considered in this study. Namely, these are addiction, so spending more time on social media, and Facebook as representative for social media. There are several possibilities why there is a mediating effect in the study by Ho et al. (2021), but not in this study. Firstly, the other research shifts the focus on Facebook rather than on all social media, and Facebook might be more prevalent for poor sleep quality and/or

depressive symptoms. Secondly, the other research focusses on addictions rather than on simply using social media, that is why participants spend more time on social media than in this study. Therefore, the number of hours using social media must be higher. Thirdly, the sleep quality reported in the other study is poorer than in this study, and this results in a mediating effect.

Before giving further possible explanations of this result, it must be clarified that the p value in the fourth hypothesis is very close to the cut-off point, meaning that there is almost a mediating effect of sleep quality on the relationship between social media usage on depressive symptoms. Therefore, it is very close for a mediating effect. However, some explanations for a non-significant effect are found. One possible reason is, that the sleep quality of an individual is not poor enough to have a mediating effect. In the PSQI, the score must be higher in order to be poorer with regard to sleep quality. Therefore, a person who has a score of 12 is sleeping poorer than a person with a score of 4. In the study of Huang & Zhu (2020), the sleep quality must be at least >16 to lead to depressive symptoms. As the poorest sleep quality reported in this study is 11, no participant is over this cut-off point. This means, that the sleep quality is simply not poor enough in order to have an effect on depressive symptoms.

Next to that, it might be that social media does not affect sleep quality as much as other things do. For example, Demirci et al. (2015) conducted research in a relationship between smartphone usage, depression and sleep quality and found a negative mediating effect of sleep quality on smartphone usage and depressive symptoms. Therefore, there might be different factors involved which explain this relationship. As already indicated by Wong et al. (2020), the hormones are affected by the blue light of the smartphone, which could be a reason. Therefore, as social media is mainly used on a smartphone, the actual reason why social media has an effect on sleep quality and depressive symptoms is the smartphone usage. Lastly, as there is an effect on different relationships present, for example from social media usage on sleep quality and depressive symptoms, it might be that the relationship can be explained also otherwise, for example by a moderation effect.

Limitations

Although significant results have been found, the study has some limitations which must be mentioned. Firstly, the sampling procedure was not optimal. It is questionable, if the

generalization to a larger population is possible, as the sample mainly consists of Psychology students and of people in the social environment of the researchers.

Another limitation is the high drop-out rate of people in the study. As can be seen in the participant's section, data of 171 people must be deleted due to several reasons, like a failed attention check, or incomplete responses. As this high drop-out rate is not usual, some reasons must be identified. Firstly, many researchers focussing on different constructs combined into one big questionnaire resulted in a long study, where participants need 45-60 minutes to finish. It is expected that this is too long, why people dropped out. Secondly, some instructions are unclear. The people had to indicate how many hours they spend on social media while laying in bed before sleeping in a format of hours.minutes. This led to confusion among some participants, as sometimes the numbers are written in a wrong format. Lastly, as many researchers included their questionnaire, the format of the study is varying.

The last possible limitation is, that the people must estimate the hours spent on social media instead of looking into the settings of the smartphone. Although it is still a reliable source, looking into the settings would be more reliable (Buysse et al., 2010). As the phone settings are more complicated to find and instructions were needed, and this might lead to a higher drop-out rate, the estimation is selected.

Further research

The results of this study clearly show a relationship between social media usage before bedtime, sleep quality and depressive symptoms, although there is no mediating effect present. Therefore, this topic must be investigated with other hypotheses. As an example, the relationship might be explained by a moderator effect instead of a mediation effect. A possible hypothesis might be the following: '*Sleep quality moderates the relation between time spent on social media before bed and depressive symptoms'*. By transforming sleep quality from a mediation variable into a moderator variable, it creates independence for sleep quality. It can be hypothesized, that sleep quality then increases the strength of the relationship positively, so increasing depressive symptoms when sleep quality is involved. As already mentioned in a paragraph above, sleep quality is a very subjective term and therefore it might be more appropriate to include it as a moderator.

It might also be, that there is another effect present, which is not hypothesized. According to Tavernier & Willoughby (2014), social media usage reduces sleep quality, and sleep quality has an effect on social media usage. This clearly shows that the relationship between sleep quality and social media is bidirectional, so both having an effect on each

other. It might be investigated further, if depressive symptoms also have a bidirectional relationship with social media usage and/or sleep quality.

Next to that, it might be commonly known that social media usage in general may be distressing and harmful for the well-being and mental health of an individual, as this study indicates through the finding of a significant relationship between the use of social media before bedtime, sleep quality and depressive symptoms. As sleep quality and depressive symptoms have an effect on the general functioning of an individual, and the social media usage before bedtime is one factor involved, further research can focus on interventions on how to inform the general society on this issue, or on interventions how everyone can actively cope with the amount spent on social media before bedtime, or even reduce the social media usage before bedtime.

Conclusion

The aim of the study is, to investigate to what extent sleep quality mediates the relationship between social media usage before bedtime and depressive symptoms among 18–30-year-old young adults. As can be seen by the results of this study, social media usage before bedtime has a significant effect on both sleep quality and depressive symptoms, although only a partly mediation effect is present. Also, sleep quality influences depressive symptoms. Reasons for this are multidirectional. When investigating the relationship between social media usage on depressive symptoms and on sleep quality, it becomes evident that the entertainment, as well as cyber mobbing are possible reasons. Next to that, sleeping poorly can cause daytime sleepiness, which can increase the likelihood of depressive symptoms.

As 60% of the people in the population use social media on their smartphone, and an effect of this on depressive symptoms and sleep quality is found, the question arises if people in general are aware of this issue and tend to ignore it, or simply do not know that spending much time on social media might have an effect on depressive symptoms and on the sleep quality of oneself (Hysing et al., 2015). Also, there might be the possibility that the advantages outweigh the disadvantages for individuals, such as the communication with relatives and friends outweighs the influence on the mental health. In order to increase the sleep quality and decrease depressive symptoms, it is important that people in the society are actually aware of this issue and change their behaviour if too much time is spent on social media before bedtime.

Every individual should reflect on their own behaviour regarding social media usage especially before bedtime, as it can have serious consequences without being aware of this

issue. If individuals still want to spend time on social media before sleeping, the amount of time takes a big role. Spending more time on social media before bed increases the likelihood for a bad sleep quality and depressive symptoms. There are settings in the own smartphone by which one can regulate and limit their time using social media. A step-by-step approach of using social media half an hour less per week might be suitable for most people, or try to deal with other things than spending time on social media, for example reading a book.

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Appendices

Appendix A

Questions if and how long social media is used before sleeping

1. Do you check social media while laying in bed before going to sleep? Yes/No
2. Think about the time of night that you usually go to bed before falling asleep. Please estimate how much time you spend on social media while you are laying in bed before falling asleep. For example, if you go to bed at 11pm and lay in bed, using social media until 12 pm each night, your average screen time before falling asleep would be 1 hour.

Appendix B

PHQ for depressive symptoms

Over the *last 2 weeks*, how often have you been bothered by any of the following problems?	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself—or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3

8. Moving or speaking so slowly that other people could have noticed? Or the opposite—being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead or of hurting yourself in some way	0	1	2	3

Appendix C

Pittsburgh Sleep Quality Index (short form)

Instructions. The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month.

Please answer all questions.

1. During the past month, when have you usually gone to bed?
   - ○ —
2. During the past month, how long (in minutes) has it taken you to fall asleep each night?
   - ○ —
3. During the past month, when have you usually gotten up in the morning?
   - ○ —
4. During the past month, how many actual hours of sleep did you get at night? (This may be different than the number of hours you spend in bed.)
   - ○ —

For each of the remaining questions, check the one best response. Please answer all questions.

- (5) During the past month, how often have you had t rouble sleeping because you…
  - ○ Cannot get to sleep within 30 minutes
    - ▪ Not during the past month —
    - ▪ Less than once a week —
    - ▪ Once or twice a week —
    - ▪ Three or more times a week —
  - ○ Wake up in the middle of the night or early morning

- - Not during the past month —
    - Less than once a week —
    - Once or twice a week —
    - Three or more times a week —
  - Have to get up to use the bathroom
    - Not during the past month —
    - Less than once a week —
    - Once or twice a week —
    - Three or more times a week —
  - Cannot breathe comfortably
    - Not during the past month —
    - Less than once a week —
    - Once or twice a week —
    - Three or more times a week —
  - Cough or snore loudly
    - Not during the past month —
    - Less than once a week —
    - Once or twice a week —
    - Three or more times a week —
  - Feel too cold
    - Not during the past month —
    - Less than once a week —
    - Once or twice a week —
    - Three or more times a week —
  - Feel too hot
    - Not during the past month —
    - Less than once a week —
    - Once or twice a week —
    - Three or more times a week —
  - Have bad dreams
    - Not during the past month —
    - Less than once a week —
    - Once or twice a week —
   - Three or more times a week —

- o Have pain
  - Not during the past month —
  - Less than once a week —
  - Once or twice a week —
  - Three or more times a week —

    Not during the past month —
  - Less than once a week —
  - Once or twice a week —
  - Three or more times a week —
- (6) During the past month, how would you rate your sleep quality overall?
  - o Very good
  - o Fairly good
  - o Fairly bad
  - o Very bad

- (7) During the past month, how often have you taken medicine (precribed or "over the counter" to help you sleep?

- (8) During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?
  - o Not during the past month —
  - o Less than once a week —
  - o Once or twice a week —
  - o Three or more times a week —
- (9) During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?
  - o Not during the past month —
  - o Less than once a week —
  - o Once or twice a week
  - o Three or more times a week
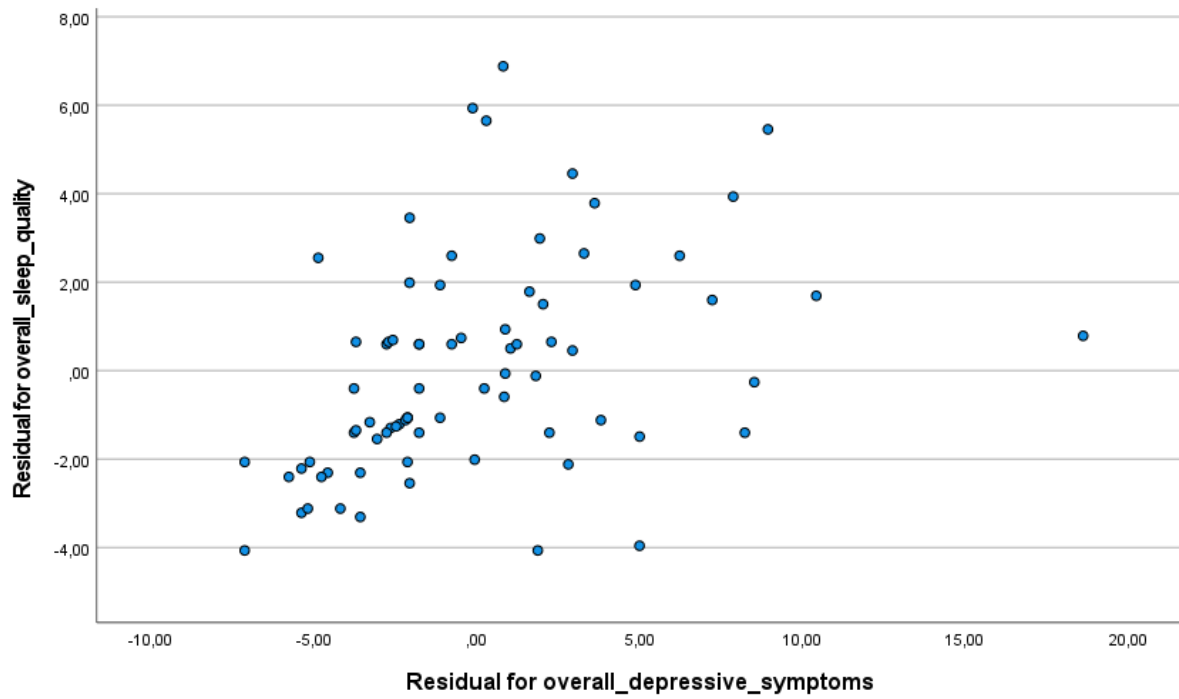
Figure A: Independence of residuals, the equal variance of residuals, and the linearity in the relationship between residuals for sleep quality as an independent variable and depressive symptoms as a dependent variable
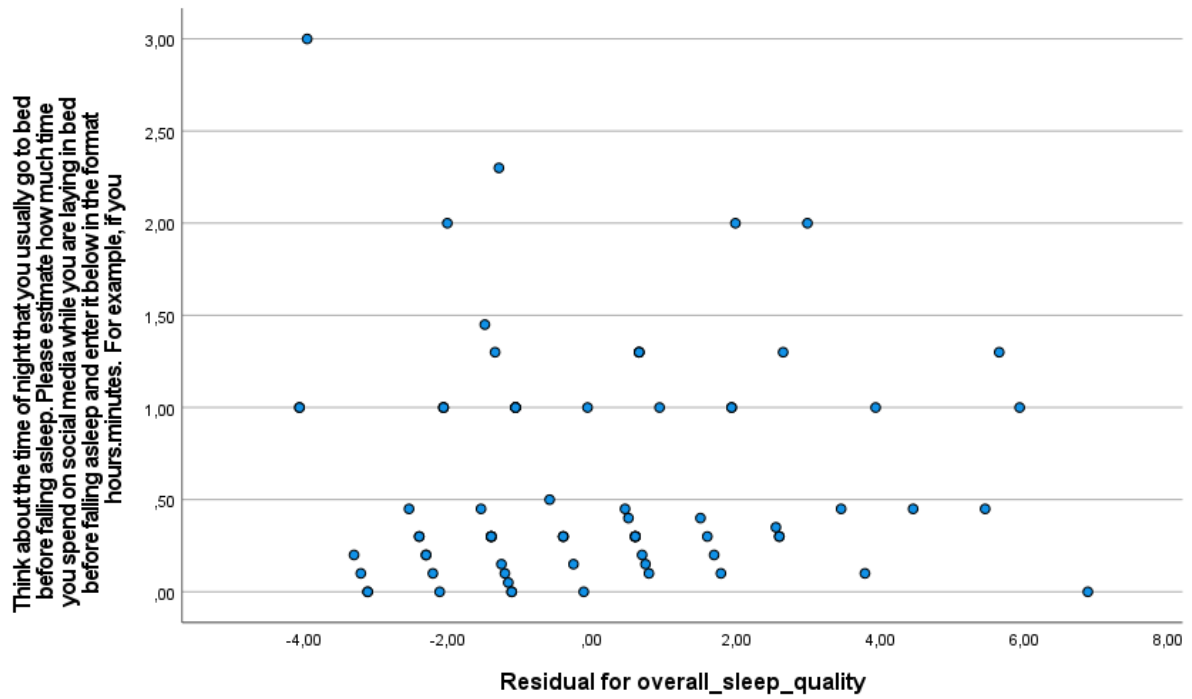
Figure B
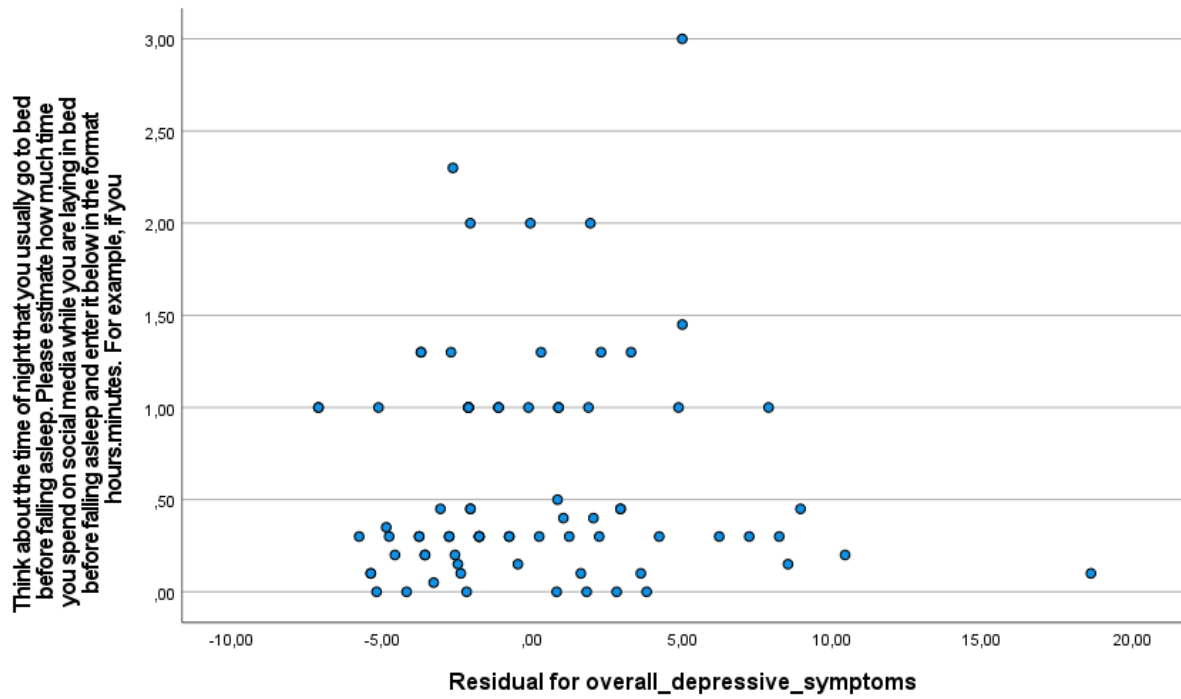
Figure B: Independence of residuals, the equal variance of residuals, and the linearity in the relationship between residuals for social media usage as an independent variable and depressive symptoms as a dependent variable
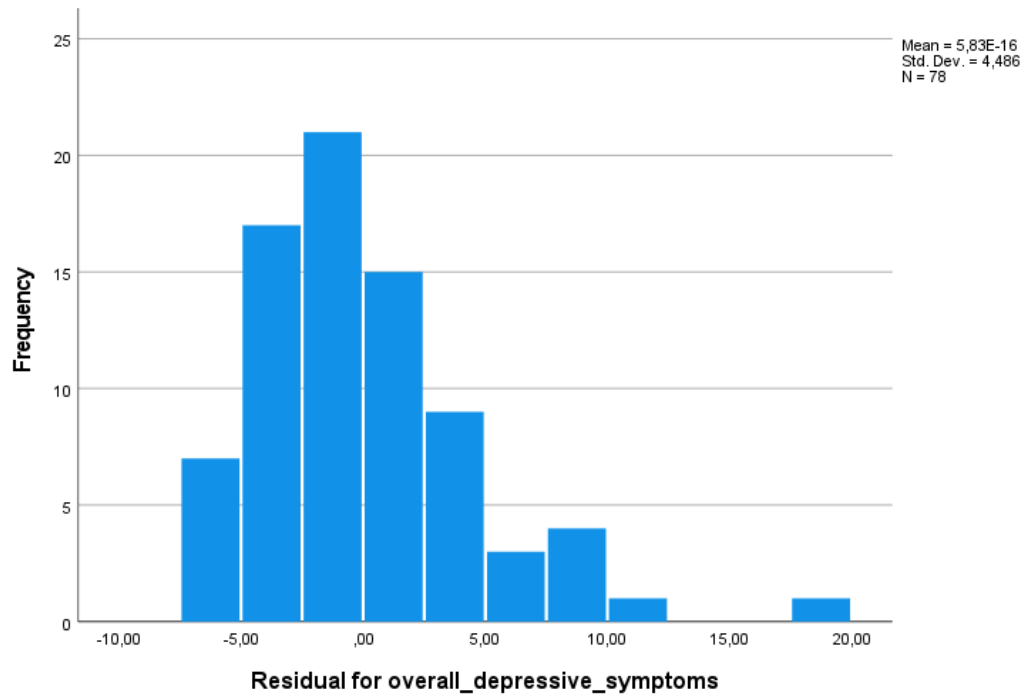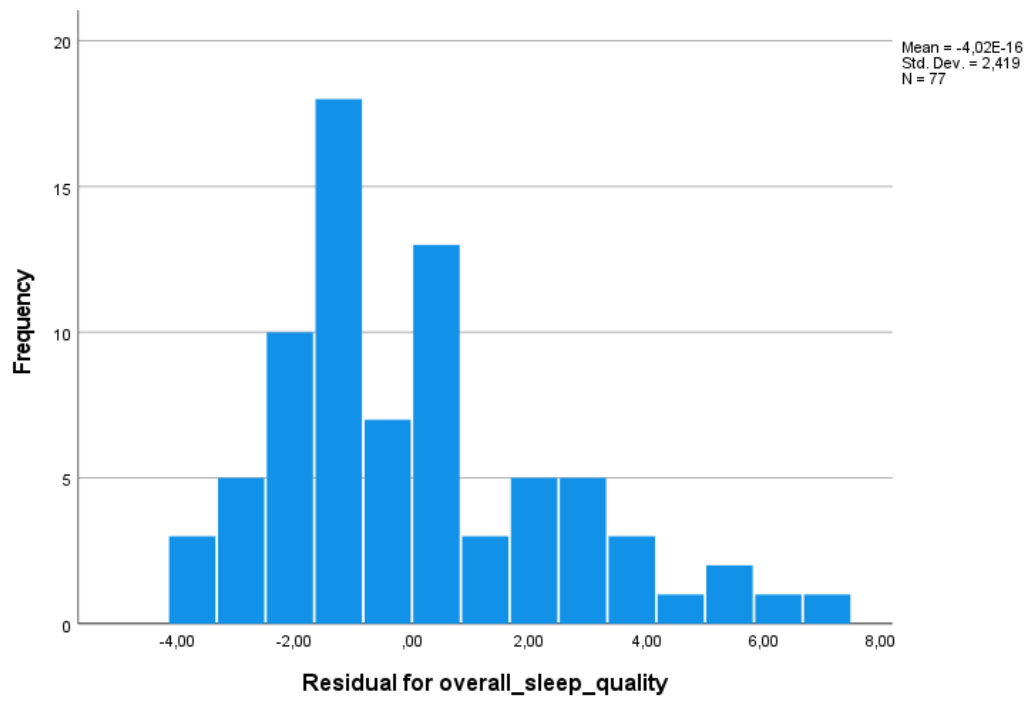
Figure C

Figure C: Independence of residuals, the equal variance of residuals, and the linearity in the relationship between residuals for social media usage as an independent variable and sleep quality as a dependent variable

Figure D

Figure D: Normality of residuals of depressive symptoms

Figure E

Figure E: Normality of residuals of sleep quality