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Frederike Spath, BSc

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Assoz. Prof. Giorgia Silani, Privatdoz. PhD

Contents

THEORETICAL PART

1	Introduction.....	6
2	Alcohol Consumption	7
2.1	Alcohol, Health and Mental Health Problems	7
2.2	Alcohol Consumption during COVID-19 Pandemic	8
2.3	Risk Factor Alcohol	9
3	Loneliness	10
3.1	Loneliness, Health and Mental Health Problems	10
3.2	Loneliness and Alcohol Consumption	11
3.3	Living Alone	12
3.4	State and Trait Loneliness	13
4	Stress	13
4.1	Stress, Health and Mental Health Problems.....	13
4.2	Stress and Alcohol Consumption	14
4.3	State and Chronic Stress.....	15
5	Daily Variation.....	15

EMPIRICAL PART

6	Aim of the Study	18
7	Research Questions.....	18
8	Hypotheses.....	19
9	Methods	20
9.1	Sample	20
9.2	Study Procedure	21
9.3	Instruments.....	22
9.4	Data Preparation.....	25
9.5	Statistical Analysis	25
10	Results.....	26
10.1	Descriptive Statistics	26
10.2	Statistical Analyses	28
10.3	Exploratory analysis.....	37
11	Discussion	42
11.1	Summary and Interpretation of the Results.....	42
11.2	Advantages, Limitations and Outlook for further research.....	49

11.3	Current relevance of this study.....	51
12	Conclusion	51
13	Abstract	53
13.1	English Abstract	53
13.2	German Abstract	54
14	References.....	55
15	List of Figures	67
16	List of Tables	68
17	List of Abbreviations	69
18	Appendix A. Information about Distributions.....	70
18.1	State Loneliness.....	70
18.2	State Stress	72
18.3	Alcohol Consumption	74
18.4	Depressive Symptoms	79
18.5	Chronic Stress	81
18.6	Trait Loneliness.....	83
19	Appendix B. Scatterplots.....	85
19.1	State Loneliness.....	85
19.2	State Stress	86
19.3	Depressive Symptoms	88
19.4	Trait Loneliness.....	90
19.5	Chronic Stress	91
19.6	Living Alone	92
20	Appendix C. Questionnaires	93
20.1	UCLA-LS-3.....	93
20.2	PSS-10.....	94
20.3	PHQ-9.....	95

THEORETICAL PART

1 Introduction

Alcohol consumption is, along with mental health issues, an increasing problem and risk in the modern society. This study proposes to investigate multiple influences on alcohol consumption, focusing on loneliness, stress, and underlying risk factors. It is known that alcohol promotes risky behavior and negatively influences mental and physical health (World Health Organization, 2018). Previous research, mostly executed using clinical samples and experimental settings, suggests associations between loneliness and alcohol consumption (Åkerlind & Hörnquist, 1989; Medora & Woodward, 1991). A significant connection was found between stress and alcohol consumption (Dawson et al., 2005; Kolb, 2016). Research also suggests a link between depression, stress and loneliness (Donovan et al., 2017; Newhouse & Albert, 2015) and that living alone leads to higher levels of loneliness (Smith & Victor, 2019). However, little is known about the connection between these effects. Using a multi-level investigation, this study combines these aspects to evaluate the effect of risk factors on the influence of loneliness and stress on alcohol consumption. Additionally, this study examines the influence of daily variation. Previous results in this field relied mostly on clinical samples and experiments, which is not readily applicable to a broad, healthy population.

Especially during the global COVID-19 pandemic, mental health, and mental hygiene play an important role. Researchers found higher levels of loneliness, stress and depressive symptoms during COVID-19 lockdowns, which also depends on worries about the critical situation (Banerjee & Rai, 2020; Collins et al., 2021). This underlines the relevance of this studies' outcome. The present research uses the naturally induced feelings of loneliness and stress during the COVID-19 lockdown to gather data with an ecological momentary assessment (EMA) in a natural setting and daily life. This natural setting in a non-clinical sample allows the application of the results to a broad population and the identification of underlying risk factors that might increase the consumption of alcohol. The present study aims to help identifying risk factors, mutual dependencies, direct impacts and allowing more detailed research for preventive measures in specific risk groups.

It should be noted that data for this thesis was collected as part of a large-scale study, which focused on impacts of COVID-19 lockdowns on several factors (for example rewards, consumption behavior etc.). In the following I will use the terms momentary stress and state stress, as well as momentary loneliness and state loneliness, as synonyms.

2 Alcohol Consumption

2.1 Alcohol, Health and Mental Health Problems

First, it is crucial to point out the importance of alcohol consumption as well as its risks. According to Bühringer (2002) around 90% of all adults in Germany consume alcoholic beverages. This suggests that alcohol plays an important role in society. Drinking alcohol socially is considered to be a part of dining and other social activities, such as celebrating special occasions and in order to facilitate social contact. Thus, the alcohol industry is a significant economic factor, which shows its importance and omnipresence in daily life. Alcohol is even though it is so wildly accepted, a drug, which can lead to addiction and various related problems. Bühringer (2002) estimates that around four million German adults between the age of 18 to 59 suffer from acute alcohol-related problems.

The relationship between alcohol consumption and health problems has been studied for several decades. In 1994, Edwards et al. (as cited in Bühringer, 2002) found a correlation between increased alcohol intake and several health and social problems, such as “alcohol dependence syndrome and related long-term effects, [...] somatic diseases (e.g., carcinoma) [and] emotional and family problems (e.g., marital problems and child abuse)” (Bühringer, 2002, p.1). Acute alcohol-related disorders include intoxication and alcohol withdrawal syndrome (Bühringer, 2002). According to the ICD-10 Classification of Mental and Behavioral Disorders (World Health Organization, 1993), Acute Intoxication (F10.0) is

A condition that follows the administration of a psychoactive substance resulting in disturbances in level of consciousness, cognition, perception, affect or behavior, or other psycho-physiological functions and responses. The disturbances are directly related to the acute pharmacological effects of the substance and resolve with time, with complete recovery, except where tissue damage or other complications have arisen. Complications may include trauma, inhalation of vomitus, delirium, coma, convulsions, and other medical complications. The nature of these complications depends on the pharmacological class of substance and mode of administration. (World Health Organization, 1993, F10.0)

Alcohol addiction has brought comorbidity with several disorders. The World Health Organization (WHO) classifies several mental and behavioral disorders due to abuse of alcohol, such as Dependence Syndrome (F10.2), Psychotic Disorder (F10.5) and Residual and Late-onset Psychotic Disorder (F10.7, World Health Organization, 1993).

In addition to mental disorders, a range of somatic disorders are caused by the harmful use of alcohol, such as liver-, lung-, gastrointestinal tract-, pancreas- and cardiovascular diseases as well as high blood pressure, cancer and nutritional problems (Bühringer, 2002; Hermans et al., 2021). The WHO specifically names liver cirrhosis and injuries from violence, road clashes and car collisions under alcohol influence as consequences of irresponsible alcohol consumption (World Health Organization, 2018).

2.2 Alcohol Consumption during COVID-19 Pandemic

It is essential to investigate changes of alcohol consumption during the global COVID-19 pandemic. Several studies confirm a feared rise in alcohol consumption during the pandemic. The Nielsen Company (2020) reported an increase of 54% of alcohol in national sales for the last week of March 2020 (beginning of the first COVID-19 lockdown in the US) compared with the same week the previous year. *The Forbes Magazine* states that alcoholic beverage sales have peaked significantly during the COVID-19 pandemic (Micallef, 2020).

Pollard et al. (2020) examined individual changes in alcohol intake and its consequences in adults from before to during the COVID-19 pandemic. The study was conducted in the US during the first COVID-19 lockdown in March 2020 with 6,000 participants. They found an average increase of alcohol consumption by one day per month in three out of four adults. A significant rise in heavy drinking in women (41% over baseline) and in the Short Inventory of Problems Scale (SIP-R, Kiluk et al., 2013) was also discovered. The SIP-R assesses problems associated with substance abuse and could be linked to increased alcohol-related problems during the past 30 days.

A similar study was conducted in Belgium by Bollen et al. (2021). They collected data from more than 1,900 Belgian students during the first lockdown period from April to May 2020. More than 17% reported a higher consumption than before the pandemic. Even though nearly all students stated that they are usually mostly drinking alcohol in social gathering, they specify that they consumed alcohol almost always alone during and because of the lockdown. This suggests a connection between loneliness and alcohol consumption during COVID-19 lockdowns.

Chodkiewicz et al. (2020) show similar results in Polish students. They include the Perceived Stress Scale (PSS-10), emphasizing that people who drank alcohol were significantly less able to find something positive about the pandemic situation and to cope with stress. These

results indicate that the consumption of alcoholic beverages during the COVID-19 pandemic could often be utilized as a stress-related coping strategy.

These studies show a general increase of alcohol consumption and alcohol-related problems specifically during the COVID-19 lockdown. For this thesis, it is interesting to examine if these changes are related to loneliness and stress.

2.3 Risk Factor Alcohol

The WHO published an online article stating that alcohol is responsible for three million deaths a year worldwide, which represents 5,3% of all deaths, a third of which occur in Europe (World Health Organization, 2018). It is the continent with the highest alcohol consumption. Europe is also the area with the highest prevalence of alcohol consumers in the population and subsequently the highest prevalence of alcohol use disorders. This continent also has the highest share of deaths caused by alcohol, among all deaths. In this publication, WHO clearly identifies alcohol as a big risk factor in the COVID-19 pandemic. During the COVID-19 lockdown alcohol consumption exacerbated health vulnerability, as well as risk-taking behaviors, mental health issues and violence (World Health Organization, 2020).

Several studies investigate alcohol consumption as a coping strategy. Dávalos et al. (2012) found that alcohol intake was positively related with macroeconomic changes, such as unemployment. Participants showed risk-taking behavior like binge drinking, alcohol abuse, driving under the influence of alcohol and dependence in order to cope with the uncertainty and stress of unemployment. Binge-drinking behavior linked to stress-coping was also found among college students in the US (Chen & Feeley, 2015). They discovered that students with higher levels of stress and loneliness also report higher alcohol intake.

Depressive symptoms also show a correlation with higher alcohol consumption (Boden & Fergusson, 2011). Most studies focus on depression in patients with alcohol use disorders, which demonstrates a bigger prevalence than in a healthy population (Dennhardt & Murphy, 2011; Foulds, 2015). Bravo et al. (2016, 2017, 2018) conducted numerous studies on the topic of the interaction between depressive symptoms and alcohol consumption. They found that alcohol-related problems often appear in connection to drinking to cope with depressive symptoms (Bravo et al., 2016, 2017). In another study they investigated the strong connection between depressive symptoms, ruminative thinking and alcohol consumption, showing that all are significantly positively correlated (Bravo et al., 2018).

This indicates that alcohol consumption is commonly used as a coping strategy in order to deal with stress and loneliness, among other factors. Easy access and social acceptance simplify the path to abusive alcohol consumption and addiction. Combining this knowledge with that of serious and long lasting mental and health problems identifies alcohol as a risk factor for comorbidities.

3 Loneliness

3.1 Loneliness, Health and Mental Health Problems

Humans rely on social contacts and depend on one another. More than that, humans thrive on interpersonal contact. This is why our psychological and physiological well-being is impaired when we become socially disconnected and lonely (Bevinn, 2011).

Several studies connect feelings of loneliness with mental health problems, such as depression and heightened mortality risk (Luo et al., 2012). Loneliness is a subjective experience and therefore the feeling of loneliness differs between individuals. Bevinn (2011) found that the quality of loneliness is affected by age, gender and how much time was spent alone. The researchers conducted a study with more than 700 participants in the US. Subjects were divided into four different age-groups and filled out a loneliness questionnaire. Elderly experienced less loneliness and if they did, they coped differently, evaluating, and then reducing its pain. Young adults had the highest scores in loneliness and especially the highest score in the painful feeling of loneliness.

The quantity of loneliness is visible in another way. There are different models that suggest loneliness is predominantly a problem of the elderly, relating here to the quantity of loneliness, not the way to cope with such. It also differs from country to country. Most Northern and Western European countries show no significant relationship between age and loneliness (Yang, 2019). The frequency of loneliness in older groups is much lower than in young adults, proving that loneliness is relevant for all age-groups and generations.

The lack of close personal ties and of perceived sources of emotional support were associated with somatic sickness, for example a significantly increased risk of cancer. It is also associated with heart disease, depression, alcohol and drug abuse, bulimia nervosa, dementia and Alzheimer's disease and suicide (Yang, 2019). Loneliness is considered to be a risk factor for mental disorders like depression, adjustment disorder, chronic stress, insomnia, anxiety and late-life dementia (Wilson et al., 2007). In a longitudinal study, depressive symptoms correlate positively with higher scores in loneliness (Donovan et al., 2017), which collectively appear to

be related risk factors for impairments in cognitive functions (Cacioppo et al., 2010; K. T. Wang et al., 2009). Cacioppo et al. (2006) conducted a longitudinal study that identified loneliness as a predictor for depressive symptoms and suggests a synergetic effect.

Loneliness is not equal to social isolation. It is an emotion, a subjective feeling, which is difficult to measure objectively. People can feel lonely among others, even if they are included in a social network, and the other way around; people who live alone are not necessarily lonely (Yang, 2019). But there is a link between living alone and loneliness (see 3.3).

Especially during the COVID-19 lockdown people were strictly socially isolated. This can promote and intensify the feeling of loneliness. Banerjee and Rai (2020) found a higher feeling of loneliness during the first COVID-19 lockdown in India. Landmann and Rohmann (2021) conducted a study in Germany during the first 8 weeks of contact restrictions (March – May 2020) and found that physical loneliness was significantly higher than emotional loneliness and social loneliness. They introduced *physical loneliness* as a new dimension of loneliness, which describes the feeling of missing physical company of others but still feeling emotionally and socially connected. Social loneliness consists of having an active social network and emotional loneliness describes the emotional connection to others. Results also indicated that younger individuals felt more physically lonely and missed the company of others more, even though older participants reported a greater lack of social contacts.

3.2 Loneliness and Alcohol Consumption

Several studies showed a correlation between the feeling of loneliness, solitude, and alcohol consumption. According to Mohr et al. (2001), solitary drinking is associated with drinking to cope with negative experiences, whereas social drinking is connected to drinking to increase positive experiences.

Clinical alcoholics feel significantly higher levels of solitude compared to a healthy control group (Boulze-Launay & Rigaud, 2020). Another study that accompanied alcoholics for over two years showed changed scores in loneliness are correlated with changed scores in social network, psychological well-being and alcohol consumption (Åkerlind & Hörnquist, 1989). Medora and Woodward (1991) found a significant positive relationship between loneliness and number of years alcohol was consumed. The results also showed that female alcoholics were feeling significantly lonelier than male alcoholics.

Studies with non-alcoholic, but social drinkers concluded the opposite. Canham et al. (2016) investigated middle-aged men and women, who did not show any symptoms of alcohol

addiction, but were rather social drinkers (alcohol consumption around one to two days per week, only in a social context). The sample consisted of more than 2,000 adults aged 50 years and older, who reported drinking alcohol within the last three months. Results suggest that among this age-group loneliness was associated with reduced alcohol intake, not with at-risk or binge-drinking.

Interestingly, Purser (2020) conducted a similar study with older adults (around 61 to 91 years old), which indicates that higher levels of loneliness predict higher alcohol intake. Conclusively, he found that higher levels of social engagement predicted lower levels of drinking. Purser (2020) also connected lower levels of social engagement with a higher feeling of loneliness.

3.3 Living Alone

People who live alone show higher levels of loneliness and social isolation (Smith & Victor, 2019). This is increasingly becoming a problem, as, according to Klinenberg (2016), living alone is becoming more and more popular. Forty percent of all households in Scandinavia and more than 30% of households in Western and Middle Europe were one-person households in 2013 (Klinenberg, 2016), and the trend is rising (Yang, 2019). In 2014, the highest percentage of one-person households in Europe was found in Austria with around 31% (Yang, 2019). In an interview with 300 people living in a one-person household, more than 80% reported that they felt lonelier than when they were living together with another person. Living alone is correlated to social isolation and loneliness, which are suggested risk factors for public health (Klinenberg, 2016). The UCLA loneliness scale (D. Russell et al., 1980) confirms a positive relationship between loneliness and time spent alone.

Shaw et al. (2021) investigated the association of living alone, lack of emotional support and loneliness as predictors of suicide and self-harm in a longitudinal study. The results indicate that for men, living alone was associated with death by suicide and self-harm. They suggest only a modest relationship between loneliness and suicide. For women there was no evidence that living arrangements or loneliness were associated with self-harm or suicide. People who are living alone are shown to have a higher likelihood to develop depression (Häfner et al., 2012) and lower psychological well-being (Lim & Kua, 2011).

3.4 State and Trait Loneliness

Multiple studies established a strong relationship between *state* and *trait* loneliness¹. Tam and Chan (2019) conducted a seven-day study, where participants were asked to fill out a questionnaire via an app. The app prompted individuals at multiple random time points per day to answer questions utilizing an EMA. They established that meaningfulness of activities was associated with loneliness, at both trait and state levels. These relationships were found across age, gender, and big-five personality constructs. These results demonstrate a significant relationship between state and trait loneliness.

4 Stress

4.1 Stress, Health and Mental Health Problems

The research on the topic of stress linked to mental health and physical health issues is broad. Slavich (2016) conducted a meta-analysis with focus on life stress and health. He found evidence that stress is involved in the development, maintenance and aggravation of several mental health conditions, such as anxiety disorders and depression. Hish et al. (2019) executed an experiment with around 70 students at a research institute in the southeastern United States, focusing on the relationship between stress and burnout, as well as stress and depression. They described academic stressors as most predictive of burnout, while family and monetary stressors were more predictive of depression. In both cases the influence of stressors was significant for burnout and depression.

Stress also has been associated with asthma, cardiovascular disease, stroke, chronic pain, certain types of cancer and premature mortality (Slavich, 2016). Research identifies chronic stress as a risk factor for Alzheimer's disease, accelerating its appearance (Bisht et al., 2018; Machado et al., 2014). Psychological stress can exacerbate the process of biological aging, which is often accompanied by greater immunological impairments (Graham et al., 2006). Graham et al. (2006) found evidence that prenatal and early life stress increases the likelihood of maladaptive immune responses to stress in later life.

Depressive symptoms (as well as depression and depressive episodes) and their relation and co-occurrence to stress, loneliness and alcohol consumption are well researched. Studies indicate a positive correlation between the level of depressive symptoms and psychological

¹ *State* labels a momentary and temporary condition. *Trait* describes a time enduring characteristic, which is considered to be part of one's personality.

stress (Newhouse & Albert, 2015). Wang et al. (2005) identified work stress as a risk factor for major depressive episodes. University students with a diagnosed depression reported higher levels of anxiety and stress than a healthy control groups (Bayram & Bilgel, 2008). Also the elderly struggle with comorbidity of anxiety, depression and loneliness (Domènech-Abella et al., 2019).

Stress levels have arguably increased during COVID-19 lockdowns, especially for women. Collins et al. (2021) studied the gender gap in work hours during COVID-19 lockdown and found that the gap widened as caregiving responsibilities (child- and elderly care) increased during the pandemic. This can be explained by women carrying the greater load of childcare and caregiving responsibilities. In between home-office and childcare, stress levels of women are on average significantly higher than for men. However, this is not only visible in mothers. Di Tella et al. (2020) researched the mental health of healthcare workers in Italy during the COVID-19 pandemic, considered “one of the most stressful events in recent times” (Di Tella et al., 2020, p. 1583). They describe a high level of depressive symptoms and Post-Traumatic Stress Symptoms (PTSS) in health care workers. These findings were more significant in women than in men. This is relevant for gender differences in stress levels on a separate level as well, as 84% of all healthcare workers in Austria (measured in December 2019, Wollny, 2021) are women.

4.2 Stress and Alcohol Consumption

There is evidence for a strong positive correlation of stress level and alcohol consumption (Kolb, 2016). The term of stress-induced drinking was established in the 1990's (Pelham et al., 1998). Stress-induced drinking can be conceptualized as a method of coping with chronic stress and distress. It has been established that physiological stress increases the risk of stress-induced drinking, also in social drinkers (Clay & Parker, 2018). Psychological stressors, such as stress at work or parenting adolescents, are risk factors for coping with stress-induced drinking (Cooper et al., 1990; Handley & Chassin, 2008).

Carney et al. (2000) conducted a diary study to research the effect of positive and negative daily events and perceived stress on alcohol use. They found that on days on which participants experienced more negative events they reported a bigger desire to drink, whereas on days with more positive events, a lower desire to drink was reported.

Dawson et al. (2005) researched the influence of stressors on heavy drinking, using data from more than 26,000 US citizens over the age of 18. They found a consistent positive

relationship between number of stressors and heavy drinking (more than five drinks for men, more than four drinks for women). The frequency of heavy drinking increased by 24% with each additional stressor in men and by 13% with each additional stressor in women. Ayer et al. (2011) detected that stress predicted higher alcohol consumption for men, but there was no significant association for women.

Chen and Feeley (2015) conducted a study with 280 students in the US, investigating the relationship between binge-drinking, stress, and loneliness. In this two-wave study, with each two weeks, they found a positive correlation between higher stress levels and binge-drinking behavior, but no significant correlation between higher loneliness and binge-drinking.

4.3 State and Chronic Stress

There are many studies about chronic stress, but only few that show a relationship between state stress (which is mostly addressed as worry or momentary stress) and chronic stress. Verkuil et al. (2012) found that stressful events and momentary worry prolong stress-related physiological activity, which can someday lead to health problems and chronic stress.

5 Daily Variation

Daily variation in affect, mood, and alcohol consumption has been conducted using EMA, which allows the repeated assessment of participants in real time in their daily lives (Peacock et al., 2015). Queen et al. (2014) used EMA to identify loneliness as a strong predictor for lower levels of positive affect and higher levels of distressed affect across the day. Study results indicate the highest feeling of loneliness to occur in the evenings, before going to bed (Kleiman et al., 2017).

Studies indicate that stress reaches the highest level between 7 AM to 8 AM, right after getting up (Vargas & Lopez-Duran, 2020). Research connects the cortisol awakening response (CAR), which is a sudden increase in cortisol directly after waking up, with a higher feeling of stress, loneliness and depression in the morning (Dedovic & Ngiam, 2015). The most common explanation for CAR is the body stress from waking up, but it is possible that it influences individuals' mood and affect (Vargas & Lopez-Duran, 2020). Yamanaka et al. (2019) conducted a study which investigated the effect of time of the day on the hypothalamic-pituitary-adrenal (HPA) activity and acute psychological stress. To measure stress over the day, they used the Trier Social Stress Test (TSST). Half of the participants conducted the test in the morning and half in the evening. All individuals showed a normal circadian rhythm of cortisol,

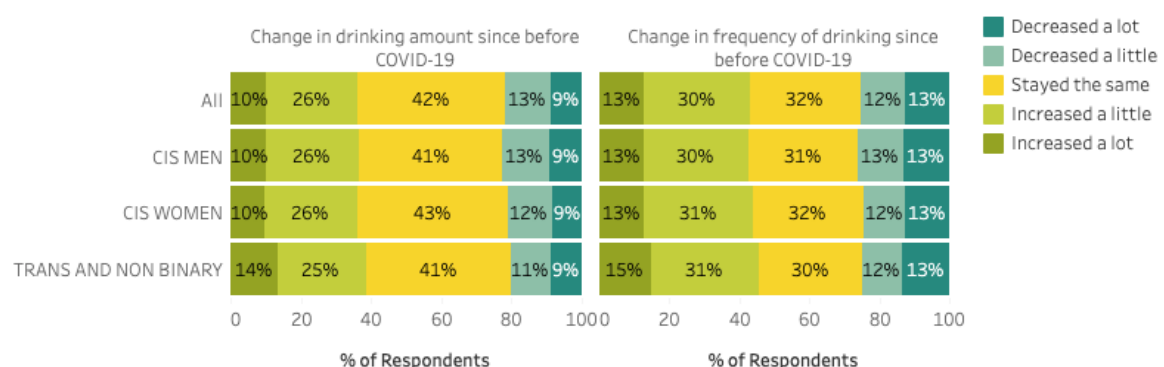
which peaks in the morning and is lowest in the evenings. Participants who performed the TSST in the morning showed higher salivary cortisol response than those participating in the evening. This indicates that people react stronger to induced stress after waking up and therefore feel more perceived stress in the mornings than in the evenings.

Naturally and in line with study results from social-drinking, individuals consume more alcohol in the evening than during the day. This is especially the case for non-alcoholics and working social drinkers. The preferred drinking time for clinical alcoholics fluctuates and varies over the day. It is mostly a consistent alcohol intake during the day (Jones et al., 2018).

The importance of the effect of stress and loneliness on alcohol in times of COVID-19 crisis is becoming clearer as the Austrian newspaper *Der Standard* published an article regarding this topic. This article states that the world's largest drug survey, the *Global Drug Survey* confirms that in times of Corona drinking alcohol out of boredom, stress or loneliness has basically become part of leisure activity (Palmai, 2021). *Global Drug Survey* conducted a special COVID-19 Edition with over 55,000 respondents who took part in the survey between May to June 2020. They found a total increase of 36% in alcohol consumption, under which 10% of respondents reported a big increase (Winstock et al., 2020). The results of this study can be seen in Figure 1. This clarifies the urgency of further investigations and identification of further risk factors, which can expedite this observed effect.

Figure 1

Change in Drinking Amount and Frequency since before COVID-19



Note. Figure is taken from *GDS COVID-19 Special Edition Report*, by Global Drug Survey, p.4. Copyright by GDS. *N* = 55,969.

EMPIRICAL PART

6 Aim of the Study

Based on the literature research, the aim of this study is to find a connection between loneliness, stress, and alcohol in a natural setting. The impact on alcohol consumption has mostly been researched in clinical populations and with diagnosed and treated alcoholics. This study is a new approach to apply and verify these results to a non-alcoholic population. The effect of living alone on loneliness and in connection to depression and alcohol consumption has only been researched with a focus on the elderly. In this study, I include younger generations and a non-clinical population to analyse differences between the age-groups.

The advantage of a natural setting at home and in daily life is that stress does not have to be artificially induced by an experiment. In this study, momentary stress was measured multiple times a day. With these real time measures it is possible to see daily variations of stress and loneliness and its connection to alcohol consumption. This allows for a more elaborate and differentiated analysis on the effect. Another aim of this study is to investigate and identify potential risk factors which interact with momentary loneliness and stress and can predict an increased alcohol intake.

7 Research Questions

The general research question for this master thesis is: Do state loneliness and state stress influence alcohol consumption and how is this effect depending on risk factors? To answer this question, I will explore seven individual research questions and, in the next section, elaborate each of the hypotheses to be tested. As I have the opportunity to measure several times a day, I will also take daily variation into account.

I have developed two basic questions (Questions 1 and 2), which focus on the main effect of independent variables (state stress and state loneliness) on the dependent variable (alcohol consumption). The following research questions build on the main question. Question 3 to 6 address the role of the risk factors on the previously named effects. The last question (Question 7) is directed at daily variations of loneliness, stress, and alcohol intake.

1. Does a higher level of momentary loneliness lead to more alcohol consumption?
2. Does a higher level of momentary stress lead to more alcohol consumption?
3. Does the effect of state loneliness on alcohol consumption depend on the living condition (living alone or with someone else)?

4. Does the effect of state stress and state loneliness on alcohol consumption depend on depressive symptoms?
5. Does the effect of state loneliness on alcohol consumption depend on trait loneliness?
6. Does the effect of state stress on alcohol consumption depend on chronic stress?
7. How do stress, loneliness and alcohol consumption vary over the day?

8 Hypotheses

The hypotheses to be tested for this study are based on the research questions. The hypotheses are as follows:

H1: Higher state loneliness predicts higher alcohol consumption.

H2: Higher state stress predicts higher alcohol consumption.

H3: Individuals living alone show a stronger effect of state loneliness on increased alcohol consumption.

H4: Individuals with more depressive symptoms show a stronger effect of state loneliness on increased alcohol consumption.

H5: Individuals with more depressive symptoms show a stronger effect of state stress on increased alcohol consumption.

H6: Individuals with higher trait loneliness show a stronger effect of state loneliness on increased alcohol consumption.

H7: Individuals with a higher chronic stress level show a stronger effect of state stress on increased alcohol consumption.

H8: Time of the day has an impact on stress, loneliness, and alcohol consumption

8a. Alcohol consumption peaks in the evening

8b. Loneliness peaks in the evening

8c. Stress peaks in the morning and is the lowest in the evening (decreases over the day)

9 Methods

9.1 Sample

The sample consists, after exclusion, of a total of 283 participants – 60 male (21%) and 223 female (79%) subjects. The mean age is 34.16 ($SD = 13.10$), ranging between 18 and 77 years. All subjects were living in Austria at the time of data collection. For a better overview, Table 1 shows that participants were divided into six age-groups.

Table 1

Participants Divided in Age-groups

<i>AGE-GROUP</i>	<i>NUMBER OF PARTICIPANTS</i>
≤ 19 years old	9
20 – 29 years old	130
30 – 39 years old	59
40 – 49 years old	43
50 – 65 years old	34
≥ 66 years old	8

Note. $N = 283$.

9.1.1 Recruiting

We conducted this study during the first COVID-19 lockdown in April in Austria, Germany, and Italy. Data was collected from the first lockdown (April 2020) and second lockdown (November/December 2020, see 9.2). For the present study I only used data from the second lockdown. For that, we contacted all participants from that survey still residing in Austria² via email. If they agreed to participate again, they were registered in our data base and received a link to the SoSci survey (SoSci Survey GMBH, online platform for professional online questionnaires). Each respondent had to create an individual code to ensure anonymous results. Subjects had to sign an informed consent before taking part in the study. After the study ended, they received monetary compensation (€ 30) which could either be donate directly (fully or partly) or paid out using bank details provided by the subjects.

² The first survey in March-April also included participants who were living in other countries e.g., Germany and Italy

9.1.2 Inclusion Criteria

From the original sample (357 participants), 74 participants had to be excluded because they did not fit the criteria (see 9.4). Inclusion criteria was a minimum age of 18 years and the requirement to be fluent in the German language, as all surveys and questionnaires were presented in German. Participants who did not live in Austria were excluded. They had to have at least 51% of the EMA questions completed and 100% of the SoSci survey, which was focused on the demographics and individual characteristics (for example chronic stress and time enduring loneliness). Diverse gender also had to be excluded, as only two participated, which would not have been representative enough to give information on the statistical relevance.

9.2 Study Procedure

The study was conducted under supervision of Prof. C. Lamm, Prof. G. Silani and Prof. U. Nater from November 21 until December 9 of 2020, at the time of the second “hard” lockdown (November 17 - December 07, 2020) in Austria. The peak of daily infections in Austria was reached on 11 November 2020 with 9,209 confirmed cases. The federal government announced the tightening of measures and the start of a "hard" lockdown from the 17th of November 2020. This resulted in closing of trade and gastronomy establishments as well as contact restrictions from 00:00-24:00 (Pollak et al., 2021).

First, basic information, demographics and general COVID-19 concerns were gathered via the app movisensXS (Movisens GmbH). Then the EMA Period started, which lasted for seven days and is further explained in the following chapter. After this week, all individuals answered another SoSci survey for post-EMA evaluations. Lastly, for another part of the large-scale study, some participants agreed to send a hair sample to determine the cortisol level and therefore the precise stress level during the survey period. I did not use cortisol level results for my thesis, as the focus lays on perceived stress.

9.2.1 Ecological Momentary Assessment Studies

The EMA method allows for collection of real time data in daily life. It enables the gathering of information through multiple entries a day in a broad population. This method is well suited to explore momentary factors, such as mood, affect, influence and behavior (Peacock et al., 2015). EMA data was collected via the App movisensXS for Android, which sends reminders to all participants to complete the survey in the app. Every participant had an individual start time for the EMA questions, so that it could be assured that the full seven days

were granted. After subjects completed the SoSci survey they could log into the app with their individual code and start the one-week-long study. MovisensXS sent five alarms over the course of one day (timeslots: 10 AM – 11 AM, 11 AM – 2 PM, 2 PM – 5 PM, 5 PM – 8 PM, before sleeping) for seven consecutive days. The last prompt was self-initiated while others were initiated by movisensXS. Participants were given the option to skip the alarm and fill out the questionnaire later (up to 30 minutes after the alarm).

9.3 Instruments

All questions used for this thesis were originally posed in German and translated into English for the purpose of this thesis. Table 2 comprehensively presents all used methods and questionnaires with the underlying measured constructs.

Table 2

Questionnaires, Methods, and Measured Constructs

<i>QUESTIONNAIRE / METHOD</i>	<i>MEASURED CONSTRUCT</i>
EMA question (VAS-Scale)	State loneliness
EMA question (VAS-Scale)	State stress
EMA questions (multiple choice, yes/no and open question)	Alcohol consumption
UCLA Loneliness Scale (UCLA-LS-3)	Trait loneliness
Perceived Stress Scale (PSS-10)	Chronic stress
Patient Health Questionnaire 9 (PHQ-9)	Depressive symptoms
SoSci survey question (one open question)	Household (living alone)

9.3.1 Alcohol Consumption

Alcohol consumption functions as the dependent variable for this thesis. The EMA survey included multiple questions in relation to alcohol. Like all questions that were conducted with EMA, these were asked five times per day. Question 3 and 4 were automatically skipped if the individual did not affirm Question 2. The questions were as follows:

1. “How strong is your desire to drink alcohol right now?”

This Questions aims to answer how much a person wants and desires to drink an alcoholic beverage at the moment. It could be answered with a visual analogue scale (VAS) with a scale from 0 (“non-existent”) to 100 (“very strong”).

2. “Which of these have you engaged in since your last entry/ since getting up (tick all that apply)?”

Alcohol consumption was listed along with other rewards such as sweets, cigarettes, online-shopping. If it was consumed since the last entry subjects had to tick the box (binary coded with 0 = “no” and 1 = “yes”). This question addresses the frequency of alcohol intake.

3. “How much did you like it?”

This question aims at the liking of alcohol and enjoyment after alcohol was consumed. It could be answered with a VAS ranging from 0 (“not at all”) to 100 (“a lot”).

4. “How many alcohol units did you consume?”

This question is the most relevant to answer this thesis’ research questions, as it gives information about the quantity of consumed alcohol units. One unit equals either one large beer (0,5l), three spirit shots (each 2cl), 1/4l of wine or two glasses of sparkling wine. The participants had the opportunity to answer this question with a number entry.

9.3.2 State Loneliness and State Stress

State loneliness and state stress are the independent variables of this thesis. They were also assessed with the EMA method (five times a day). The questions were the following:

1. “How lonely do you feel at the moment?”
2. “How stressed do you feel at the moment?”

Participants could answer using a VAS from 0 to 100, ranging from “not at all” (0) to “a lot” (100).

9.3.3 Trait Loneliness

Perpetual loneliness was assessed in the first SoSci survey using the UCLA Loneliness Scale Version 3 (UCLA-LS-3, Russell, 1996) in the German version. The English version UCLA-LS-3 is attached in the chapter Appendix C. 20.1. Study results demonstrate a high validity, high internal consistency (coefficient- α ranging from .89 to .94) and test-retest reliability ($r = .73$, D. W. Russell, 1996b). It consists of 20 items with a 4-point Likert scale. Participants report the amount of time they experienced each statement (1 = *Never*; 2 = *Rarely*; 3 = *Frequently*; 4 = *Usually/mostly*). Higher scores indicate higher levels of loneliness with a range from 20 (lowest feeling of loneliness) to 80 (highest feeling of loneliness). For better readability, I will use the term “*trait loneliness*”, because UCLA-LS-3 measures time enduring loneliness as compared to the real-time measures of loneliness achieved with EMA.

9.3.4 *Chronic Stress*

A more time enduring and consistent measure of perceived stress is conducted in the first SoSci survey using the German version of Perceived Stress Scale (PSS-10, Klein et al., 2016). The English version PSS-10 is attached in the chapter Appendix C. 20.2. Studies indicate a good internal consistency (Cronbachs alpha = .84). This screening-questionnaire includes ten items with 5-point Likert scale, which focuses on thoughts and feelings of stress during the last month. Subjects report how frequently they experienced each item (*0 = Never, 1 = Almost Never, 2 = Sometimes, 3 = Fairly Often, 4 = Very Often*). Individual scores range from 0 to 40. Higher scores indicate higher levels of perceived stress. Scores from 0 to 13 are considered low stress, 14 to 26 moderate stress and 27 to 40 high perceived stress (Klein et al., 2016). For better readability, I will use the term “*chronic stress*”, as the PSS-10 focuses on the last month, which is a more time enduring measure than the momentary measures with EMA.

9.3.5 *Depressive Symptoms*

To measure depressive symptoms, we used the German version of Patient Health Questionnaire 9 (PHQ-9, Kroenke et al., 2001). The English version PHQ-9 is attached in the chapter Appendix C. 20.3. Kroenke (2001) proved a sensitivity and a specificity of 88%. It is a screening questionnaire for the severity of depressive symptoms, but it is not a diagnostic instrument for depressive disorder and cannot lead to the conclusion for a diagnosed depression. This questionnaire consists of nine items with a 4-point Likert scale. Individuals indicate how often they have been bothered by each problem within the last two weeks (*0 = Not at all, 1 = Several days, 2 = More than half the days, 3 = Nearly every day*). Scores range from 0-27. Higher scores indicate higher depression severity. Scores from 0 to 4 show none, 5 to 9 mild, 10 to 14 moderate, 15 to 19 moderately severe and 20 to 27 severe depression (Kroenke et al., 2001).

9.3.6 *Living Alone*

In the beginning of the SoSci survey, participants were asked if they were living in a one-person household or together with others. The question was:

“How many people permanently live in your household?”

To answer, respondents could enter a number of the people living in their household, including themselves.

9.4 Data Preparation

Data had to be prepared to select the final sample and extract only variables that are important to answer this thesis' research questions. First, the start-time had to be set for every individual to 00:00, as every participant had an individual starting time. The selection of sample according to previously stated criteria was performed in RStudio. This resulted in the final sample size ($N = 283$ participants). Lastly, in order to use data for statistical analyses I had to *participant mean center* within-subject variables (state loneliness and state stress) and *grand mean center* between-subject variables (trait loneliness, depressive symptoms, chronic stress, age and household). This allows the following analysis with Multilevel Modeling (MLM). The dependent variable *Alcohol Units* did not need to be centered.

9.5 Statistical Analysis

Descriptive and statistical analyses were carried out using the prepared file with the selected sample and centered variables. Descriptive statistics was partly performed with Microsoft Excel for Mac Version 16.50. Statistical analysis and most parts of the descriptive analysis was performed with RStudio, PBC Version 1.3.1093 for Mac OS. All plots were performed using RStudio, all scatterplots were created with the ggqplot-Code. The significance level was defined in advance as $\alpha = 5\%$ ($p \leq .05$ is considered significant). To evaluate the practical relevance of the results, the standardized effect sizes were taken into account with Cohens suggested classification³ ($d = .20$ small effect, $d = .50$ medium effect and $d = .80$ large effect, Cohen, 2013; Edwards et al., 2008). The descriptive statistical representation of metric parameters is based on the mean value (M) and standard deviation (SD). The statistical analyses were carried out using MLM. The MLM is model based on the underlying hypotheses and controlled for fixed and random effect. The MLM is also known as a linear mixed model (LMM), which is fit by REML and uses t-tests with Satterthwaite's method. It allows to investigate the main effects as well as effects of interactions. Main effects in the underlying model will be the effects of all described variables on alcohol consumption. The interaction that will be checked are interactions of the proposed risk factors with state loneliness and state stress. These effects are called fixed effects. The LMM also controls for random effects, such as Variance and Standard Deviation of subjects.

³ The effect size was calculated using a custom code by OSF. The Link to this Code is in the Bibliography.

10 Results

10.1 Descriptive Statistics

Information about distribution of predictors and outcome measures is reported in Appendix A.

10.1.1 State Loneliness

State Loneliness ranges in the VAS from 0 to 100 with a sample mean of 20.46 ($SD = 25.22$). Participants in the age-group of 19 and younger reported the highest average loneliness ($M = 23.81$, $SD = 29.08$) and the age-group of 66 and older the lowest average loneliness ($M = 15.84$, $SD = 26.53$). Women reported an average state loneliness of 19.17 ($SD = 24.49$), while men reported a higher average of 25.04 ($SD = 27.19$). According to the quantile-quantile plot (Q-Q plot) and density plot state loneliness is not normally distributed. After logarithmic transformation the state loneliness was still not normally distributed (Q-Q plot, Histogram and Density plot, see Appendix A. 18.1).

10.1.2 State Stress

The average state stress level of all participants over the course of seven days was 28.02 ($SD = 26.52$) with a range from 0 to 100 (VAS-Scale). Individuals under the age of 20 reported the highest average stress ($M = 38.14$, $SD = 31.41$), while the oldest participants of 66 years and older described the lowest average stress level ($M = 8.24$, $SD = 16.62$). Females reported a mean of 29.34 ($SD = 27.32$), whereas males reported a mean of 23.67 ($SD = 22.96$). The Q-Q plot and density plot both show that state stress is not normally distributed, for the same reasons as state loneliness. The correction with the logarithmic transformation of state stress did not show the desired effect (see Appendix A.18.2).

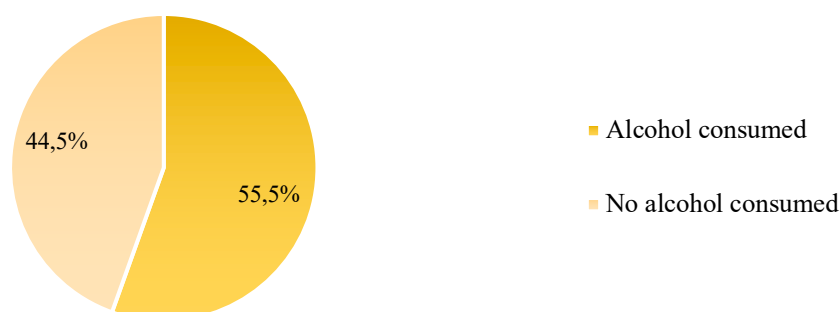
10.1.3 Alcohol Consumption

The average alcohol consumption was 0.10 alcohol units ($SD = 0.48$) per person in seven days with a range from 0 to 6. Men and women reported a similar average alcohol consumption (M: $M = 0.15$, $SD = 0.58$, F: $M = 0.09$, $SD = 0.46$). The youngest age-groups (< 20, $M = 0.08$, $SD = 0.37$ & 20 – 29, $M = 0.07$, $SD = 0.43$) reported the lowest average alcohol intake. Individuals above 66 years reported the highest average alcohol consumption with a mean of 0.25 ($SD = 0.62$). Figure 2 illustrates that 55.5% (157 participants) of all participants had at least one alcoholic beverage during the timeframe of the study. This means that 44.5%

(126 participants) did not consume any alcoholic beverages. This could affect the results greatly and might show no hypothesized effect as the alcohol intake overall was very low. Q-Q plot and Density plot show a strong trend towards zero, which also indicates that alcohol consumption is not normally distributed. The logarithmic transformation of alcohol units in Histogram, Q-Q plot and Density plot cannot correct this either (see Appendix A. 18.3). Therefore, further analyses must be conducted with the use of not normally distributed independent and dependent variables.

Figure 2

Participants Divided by Alcohol Consumption



Note. $N = 283$.

10.1.4 Depressive Symptoms

According to the Q-Q plot and density plot, depressive symptoms, trait loneliness and chronic stress were approximately normally distributed.

The participants reported depressive symptoms in the PHQ-9 with a mean of 8.48 ($SD = 5.35$) and a range of 0 to 27. This mean score indicates a severity of a mild depression. The average PHQ-9 score ($M = 12.11$; $SD = 5.05$) of the age-group of under 20-year-olds indicates a severity of a moderate depression, while the age-group of over 65-year-olds reported no depression ($M = 4.25$, $SD = 2.69$).

10.1.5 Chronic Stress

The average chronic stress in PSS-10 is 18.66 ($SD = 7.24$) and ranged between 2 and 37. The mean score from the whole sample indicates a moderate stress level. Over 65-years-olds reported an average of 8.75 ($SD = 2.73$), which indicates low stress.

10.1.6 Trait Loneliness

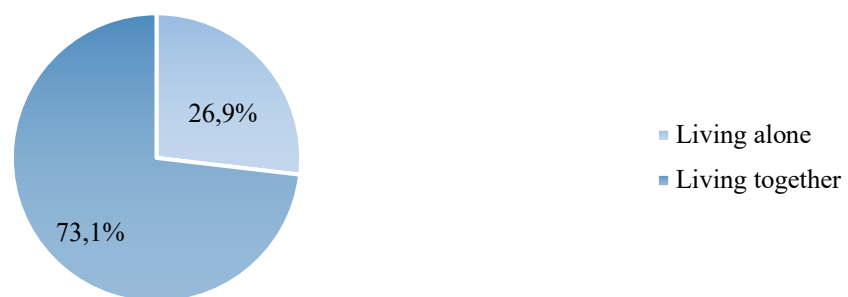
Trait loneliness, measured with UCLA-LS-3, shows a mean of 37.84 ($SD = 9.92$) with a range of 22 to 68. According to the UCLA-LS-3 manual the average score of the sample can be interpreted as a moderate feeling of time enduring loneliness.

10.1.7 Living Alone

Seventy-six participants (26.9%) reported that they are permanently living alone. Of these, 72.4% were female and 27.6% were male. Figure 3 illustrates that in total 207 subjects (73.1%) were living in a household with at least one more person. Of these individuals, 81.2% were female and 18.8% male.

Figure 3

Participants Divided by Household Condition



Note. $N = 283$.

10.2 Statistical Analyses

10.2.1 Main Effects

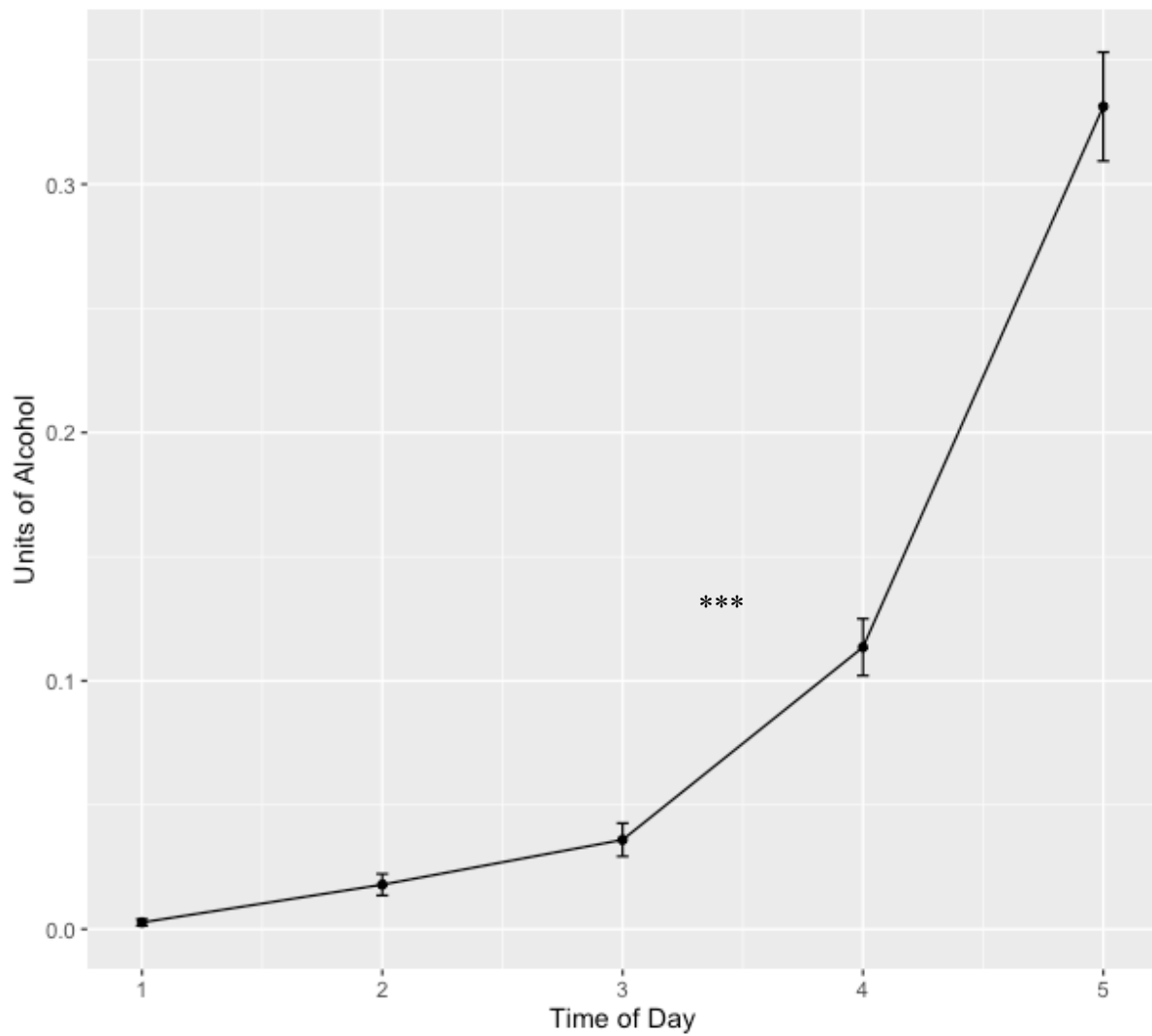
The outcome of the LMM with an ANOVA Analyses of Variance Table with Satterthwaite's method is presented in Table 3. It includes fixed and random effects. A significant daily variation in alcohol consumption with a medium effect size ($F(1, 7,361) = 466.114, p < .001, d = 0.50$) was found. Figure 4 illustrates a constant increase in alcohol intake over the course of day. State stress shows a highly significant influence on alcohol consumption ($F(1, 7,299) = 23.607, p < .001$) and a small effect size $d = 0.114$. Figure 5 shows that alcohol intake decreases as stress increases.

Table 3*Results of the Main Effect (Linear Mixed Model Fit by REML^a in RStudio)*

<i>ALCOHOL CONSUMPTION (IN UNITS)</i>			
Fixed Effects			
<i>Predictors</i>	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	-4.11*10 ⁻²	-0.08 – -0.00	.045
State loneliness	-1.62*10 ⁻⁴	-0.00 – 0.00	.794
Trait loneliness (UCLA-LS-3)	-3.98*10 ⁻⁴	-0.00 – 0.00	.722
Household (living alone)	5.23*10 ⁻³	-0.04 – 0.05	.819
Depressive symptoms (PHQ-9)	6.53*10 ⁻³	-0.00 – 0.01	.024
State stress	-1.36*10 ⁻³	-0.00 – -0.00	<.001
Chronic stress (PSS-10)	-4.68*10 ⁻³	-0.00 – -0.00	.021
Time of the day	2.48*10 ⁻²	0.02 – 0.03	<.001
<i>Interactions^b:</i>			
State loneliness * Trait loneliness	-2.29*10 ⁻⁵	-0.00 – 0.00	.487
State loneliness * Household (living alone)	-1.71*10 ⁻⁴	-0.00 – 0.00	.813
State loneliness * Depressive symptoms	-1.95*10 ⁻⁶	-0.00 – 0.00	.974
State stress * chronic stress	-2.25*10 ⁻⁵	-0.00 – 0.00	.667
Depressive symptoms * State stress	3.62*10 ⁻⁵	-0.00 – 0.00	.595
Random Effects			
σ^2	0.20		
τ_{00} subjt	0.02		
ICC	0.09		
N _{subj}	283		
Observations	7,589		
Marginal R ² / Conditional R ²	0.067 / 0.150		

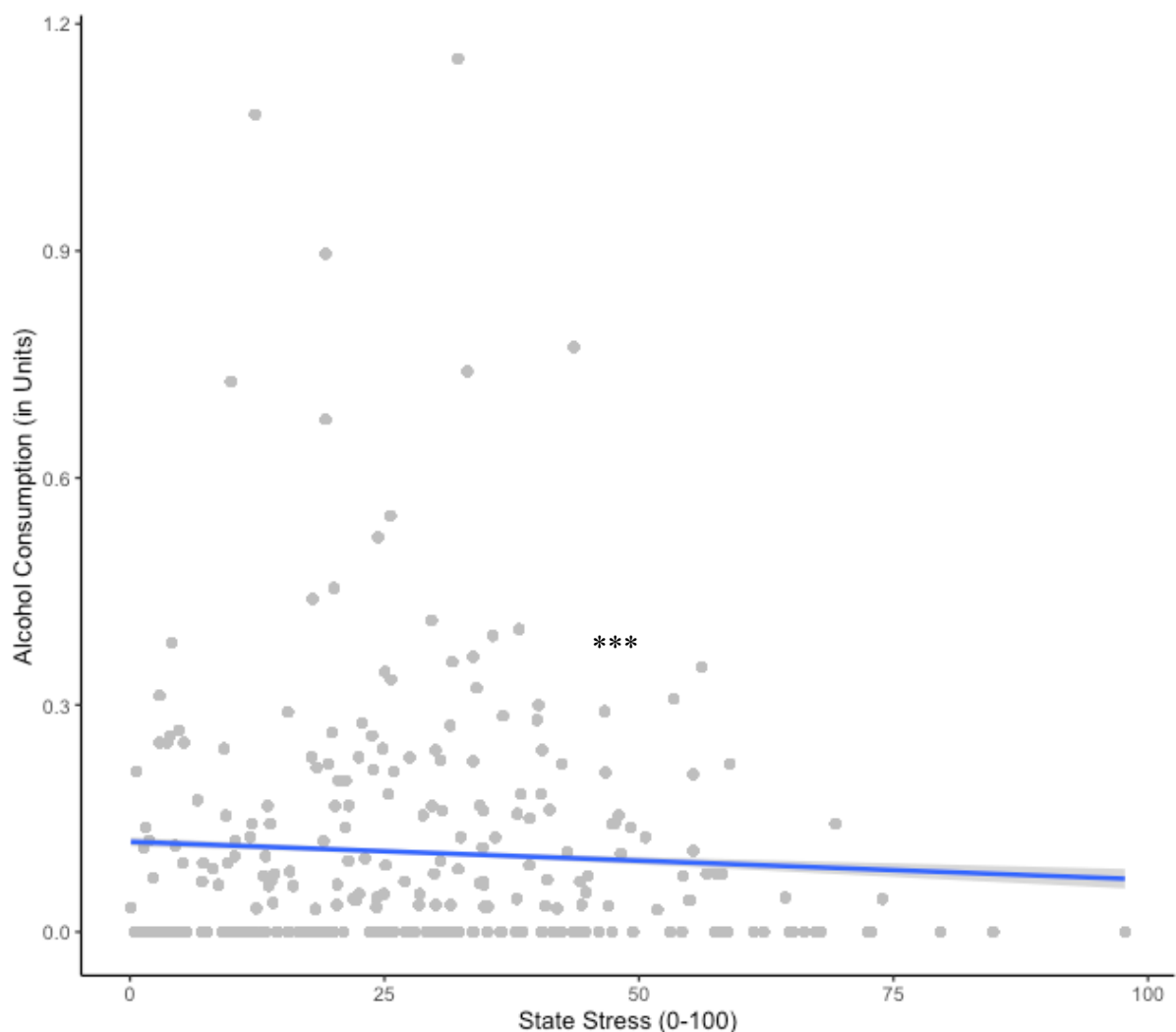
Note. T-tests use Satterthwaite's method. All Predictors have been centered. Within-subject variables (state loneliness, state stress) have been participant mean centered, between-subject variables (UCLA-LS-3 scores, PHQ-9 scores, PSS-10 scores, household) have been grand mean centered.

^a REML criterion at convergence: 9,871.6. ^b Interactions are marked with *.

Figure 4*Alcohol Consumption Throughout the Day*

Note. Timeslots: 1: 10 AM – 11 AM, 2: 11 AM – 2 PM, 3: 2 PM – 5 PM, 4: 5 PM – 8 PM, 5: before sleeping.

*** $p \leq .001$.

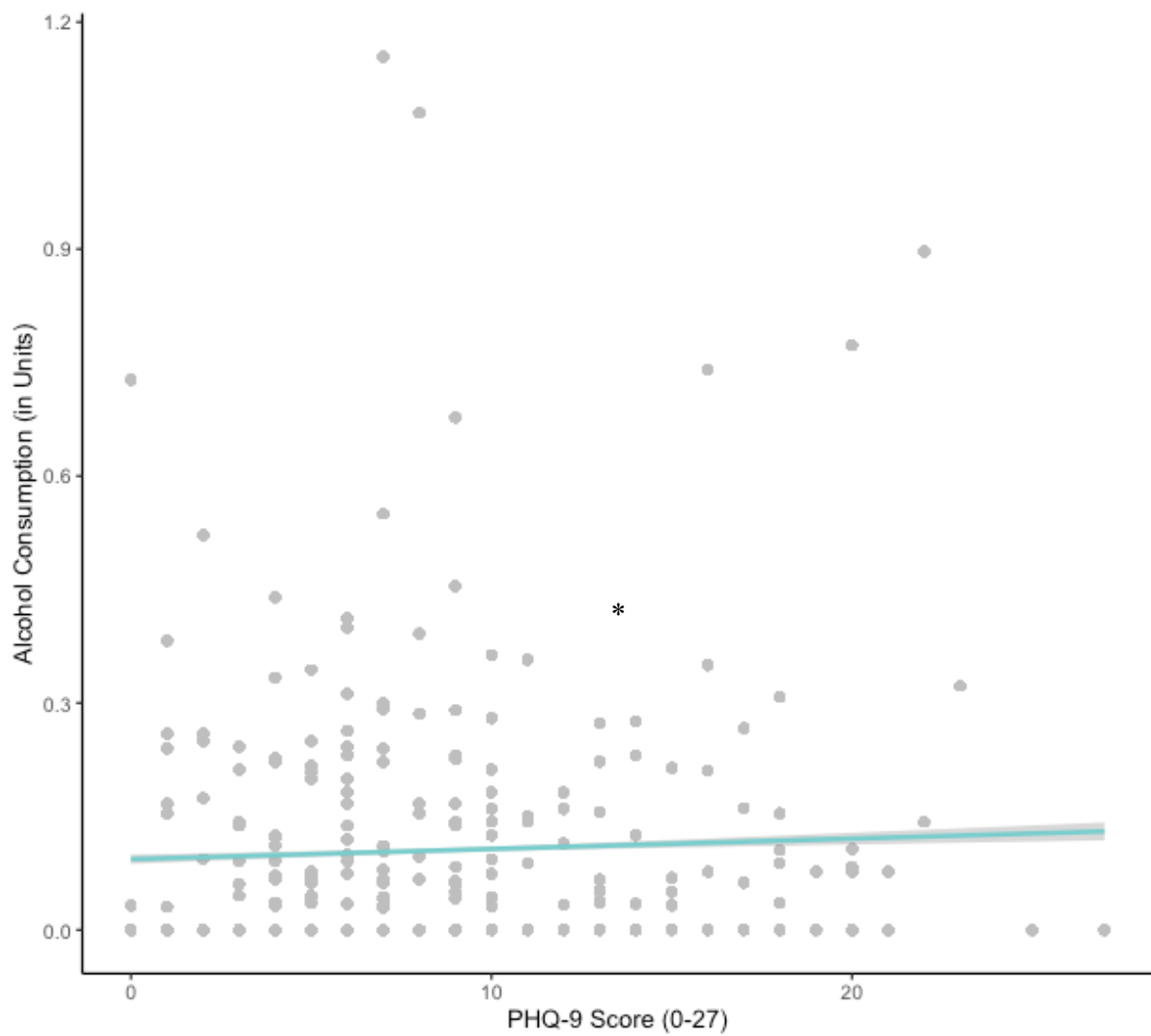
Figure 5*Main Effect of State Stress on Alcohol Consumption*

Note. State stress and alcohol units were aggregated per participant. Each point represents one participant.

*** $\leq .001$.

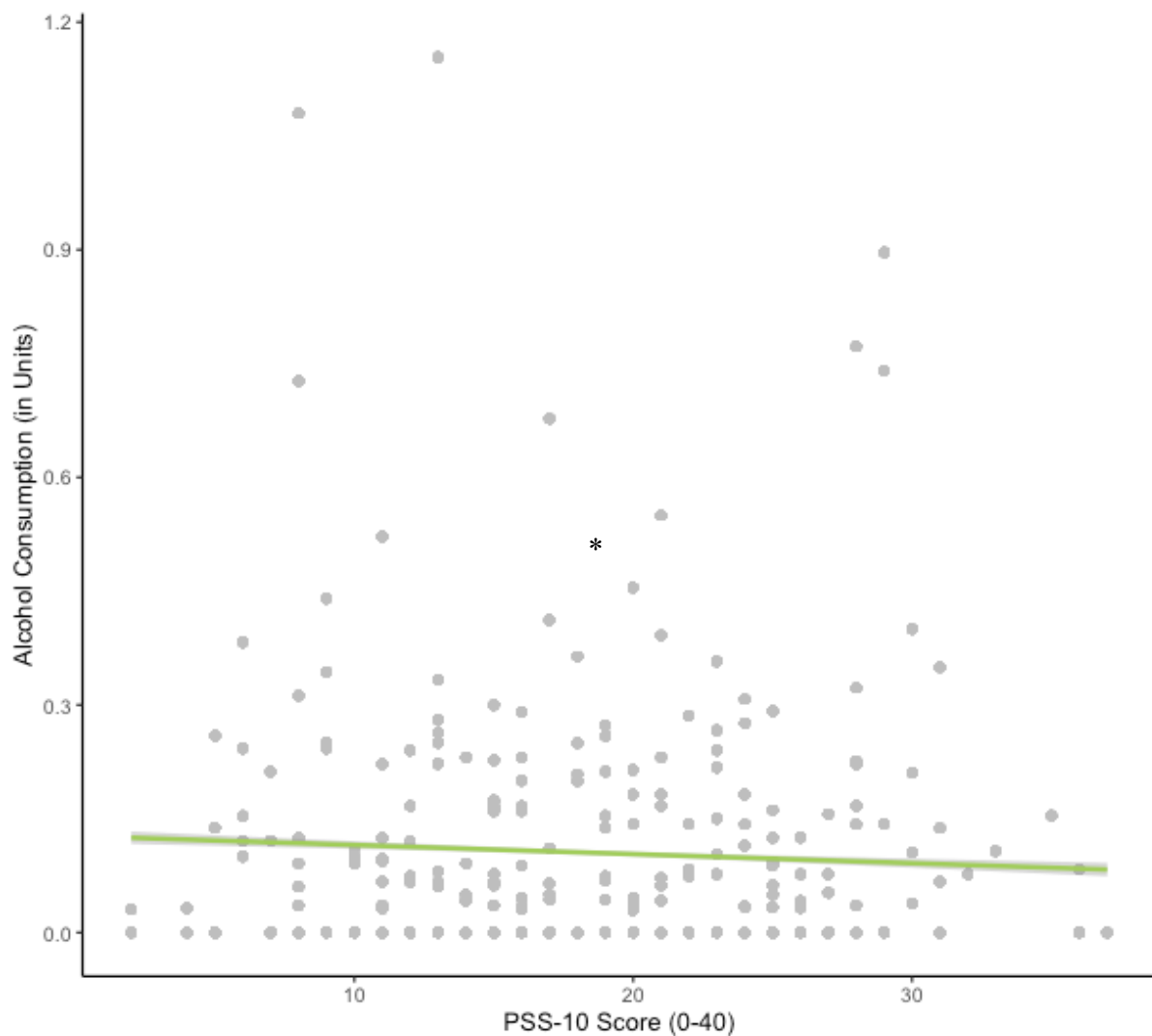
The two risk factors depressive symptoms ($F(1, 275) = 5.060, p < .024, d = 0.271$) and chronic stress ($F(1, 273.5) = 5.344, p < .021, d = 0.280$) also show a significant effect on alcohol consumption. Both indicate small effect sizes. Participants with more depressive symptoms reported a higher alcohol intake, as can be seen in Figure 6. Higher chronic stress on the other hand revolved in a decrease in alcohol consumption. Figure 7 illustrates this effect.

There appears to be no significant prediction from state loneliness on alcohol consumption ($F(1, 7296.8) = 0.444, p = .794, d = 0.006$, Scatterplot in Appendix B. 19.1). The effects of state loneliness and state stress on alcohol consumption were not dependent on risk factors (Scatterplots in Appendix B).

Figure 6*Main Effect of Depressive Symptoms on Alcohol Consumption*

Note. Alcohol units were aggregated per participant. Each point represents one participant.

* $p \leq .05$.

Figure 7*Main Effect of Chronic Stress on Alcohol Consumption*

Note. Alcohol units were aggregated per participant. Each point represents one participant.

* $p \leq .05$.

10.2.2 Daily Variation in Independent Variables

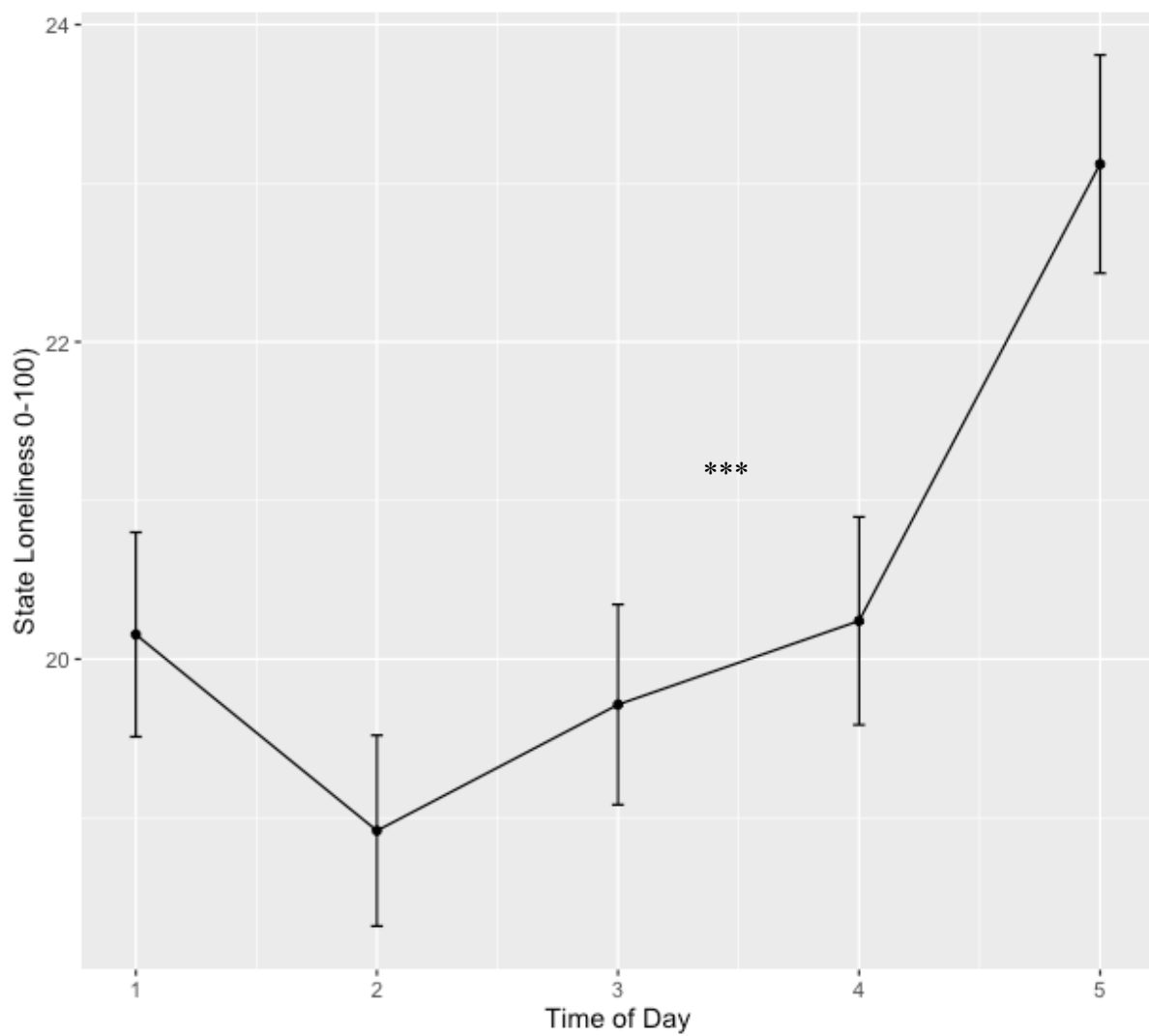
These analyses were conducted with LMM and ANOVA Analysis of Variance Table with Satterthwaite's method. Table 4 shows a significant impact from time of day on state loneliness ($F(1, 7325) = 65,412, p < .001$). Figure 8 illustrates a peak of loneliness in the evening and the low point at the second prompt at 11 AM to 2 PM. The effect size with $d = 0.189$ is small.

Table 4*Results of the Effect of Risk Factors on State Loneliness (Linear Mixed Model Fit by REML^a)*

STATE LONELINESS			
Fixed Effects			
<i>Predictors</i>	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	18.65	16.35 – 20.94	<.001
Time of the day	0.33	0.25 – 0.41	<.001
Random Effects			
σ^2	275.00		
$\tau_{00 \text{ subjt}}$	361.85		
ICC	0.57		
N_{subj}	283		
Observations	7,602		
Marginal R^2 / Conditional R^2	0.004 / 0.570		

Note. Analyses were carried out with RStudio. T-tests use Satterthwaite's method.

^a REML criterion at convergence: 65,285.5.

Figure 8*Loneliness Throughout the Day*

Note. Using ddpIy and ggplot Code in RStudio. Timeslots: 1: 10 AM – 11 AM, 2: 11 AM – 2 PM, 3: 2 PM – 5 PM, 4: 5 PM – 8 PM, 5: before sleeping.

*** $p \leq .001$.

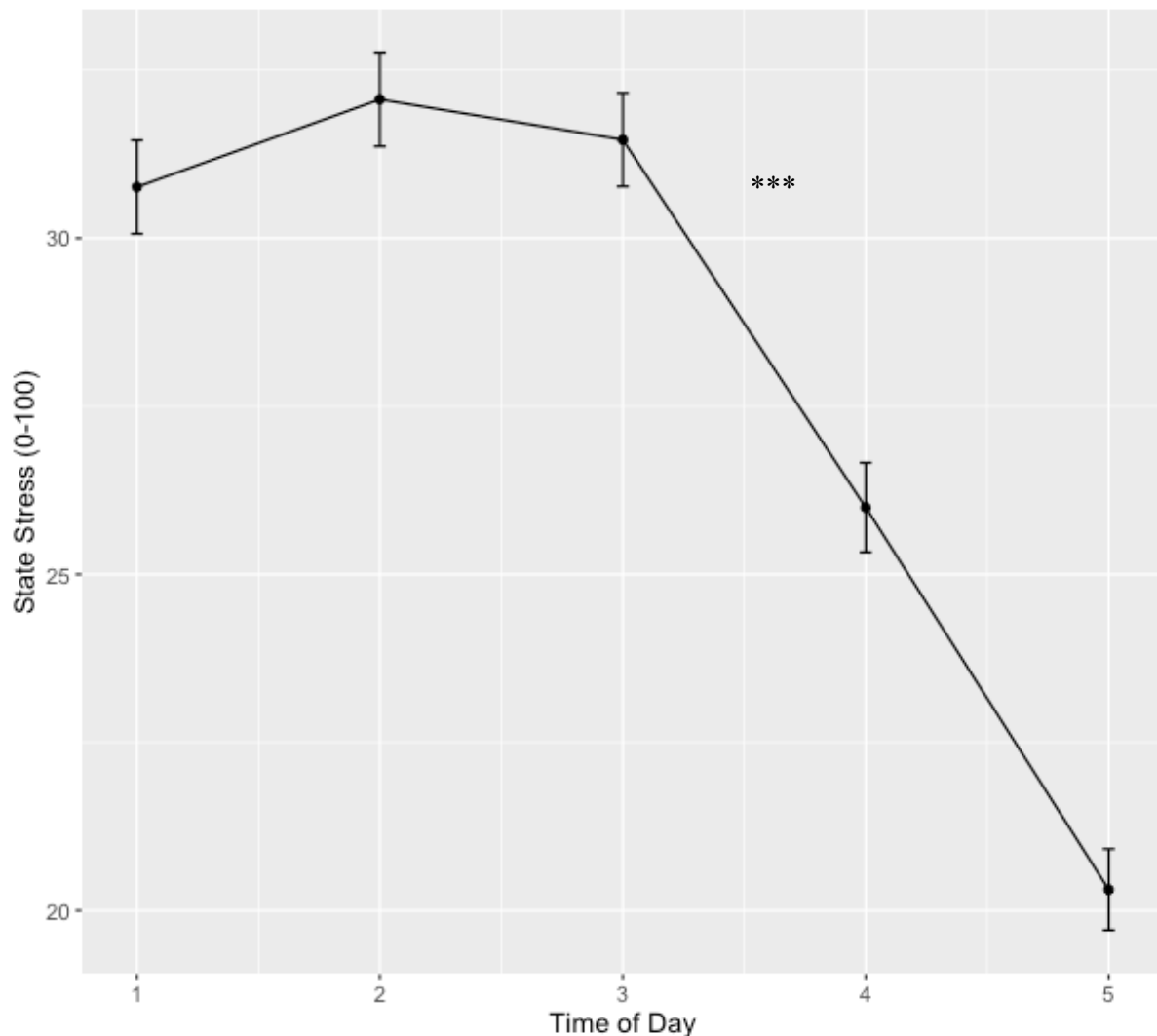
Table 5 indicates a significant daily variation in state stress ($F(1, 7331) = 320.46, p < .001$). This effect is small to medium with $d = 0.418$. Figure 9 shows that stress reaches its high point at the second entry and then decreases over the course of day with the lowest stress level before going to bed.

Table 5

Results of the Effect of Risk Factors on State Stress (Linear Mixed Model Fit by REML^a)

<i>STATE STRESS</i>			
Fixed Effect			
<i>Predictors</i>	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	33.22	31.03 – 35.41	<.001
Time of the day	-0.85	-0.95 – -0.76	<.001
Random Effects			
σ^2	369.76		
$\tau_{00 \text{ subjt}}$	318.38		
ICC	0.46		
N_{subjt}	283		
Observations	7,605		
Marginal R^2 / Conditional R^2	0.022 / 0.475		

Note. Analyses were carried out with RStudio. T-tests use Satterthwaite's method. ^a REML criterion at convergence: 67,446.9.

Figure 9*Stress Throughout the Day*

Note. Using ddpIy and ggplot Code in RStudio. Timeslots: 1: 10 AM – 11 AM, 2: 11 AM – 2 PM, 3: 2 PM – 5 PM, 4: 5 PM – 8 PM, 5: before sleeping.

*** $p \leq .001$.

10.3 Exploratory analysis

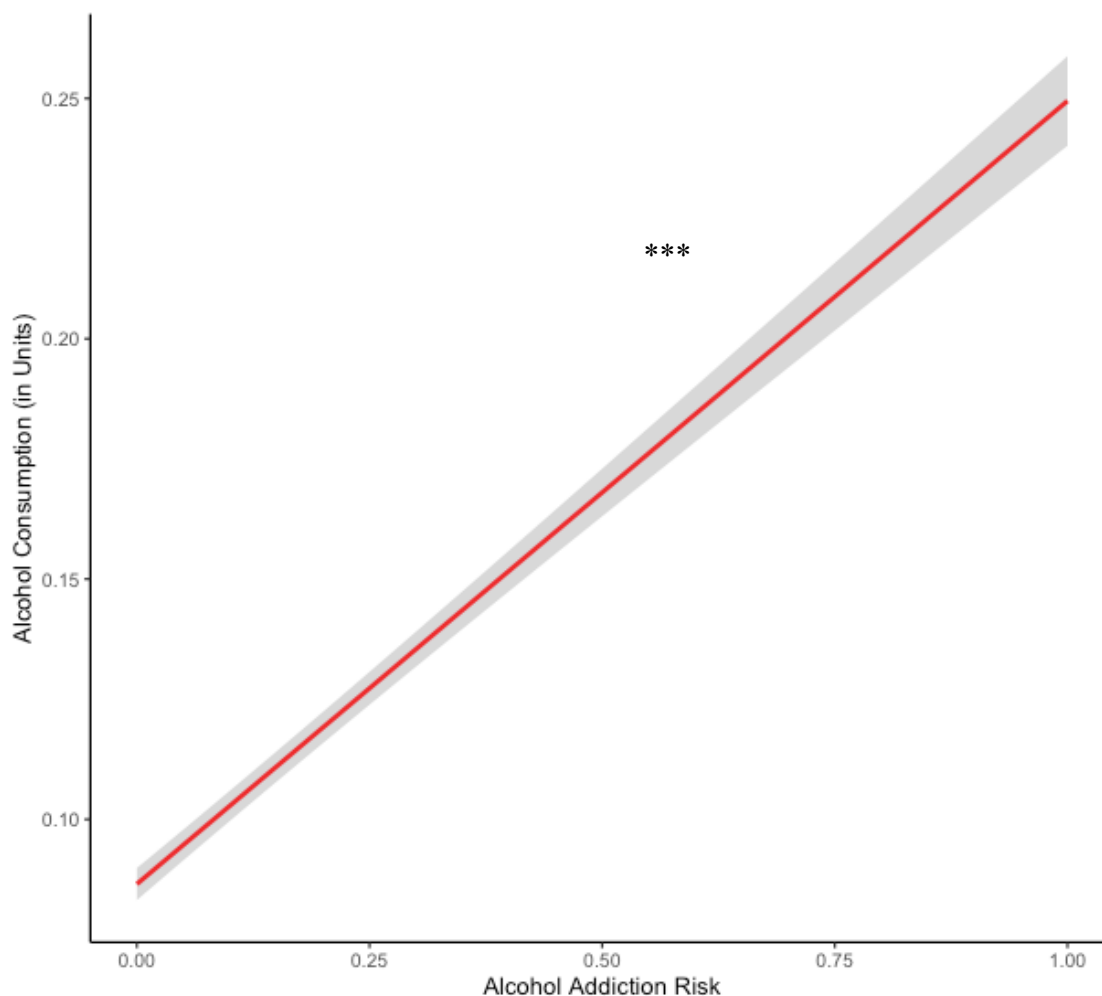
The overall alcohol intake in this sample is extremely low, which might be the reason that the results from this study are not consistent with previous research. This leads me to believe that possibly only people who have an alcohol addiction or alcohol problems use alcohol consumption to reduce stress and loneliness. I assume this might be the reason for this unpredicted outcome, as the sample most likely does not include anyone with an alcohol problem. To verify this assumption an exploratory analysis will be carried out. For this analysis I will use additional questions, which have been asked in the SoSci questionnaire upfront and hint at

a risk of alcohol addiction. This is not a diagnostic criterion but just an indicator. It consists of two variables; one holds the information of the number of symptoms (five in total), the other one is dichotomous, with 0 meaning *no risk of alcohol addiction* and 1 meaning *risk of alcohol addiction*. A participant has a risk of alcohol addiction if at least one of the five symptoms apply. With this variable I will investigate if participants with a risk of alcohol addiction show the expected effects. This analysis was also executed with MLM in RStudio.

32 participants (11.3%) reported having a risk of alcohol addiction. The mean alcohol consumption in this group is 0.25 ($SD = 0.25$), which is significantly higher ($p < .001$) than in the group of individuals who did not report any symptom that indicates alcohol problems ($M = 0.09$, $SD = 0.14$). Figure 10 illustrates that individuals with an indicated alcohol problem drank significantly more alcohol than individuals without the risk of addictive behavior.

Figure 10

Main Effect of Risk of Alcohol Addictive Behavior on Alcohol Consumption



Note. Alcohol units were aggregated per participant. Alcohol Addiction Risk (0 = No risk, 1 = Risk).

*** $p < .001$.

Table 6 shows a significant effect of indicated alcohol problems on alcohol intake with a medium to large effect size ($F(1, 278.2) = 30.157, p < .001, d = 0.658$). The interactions between state stress and risk of alcohol addiction present a significant effect on the consumption of alcohol with a small effect size ($F(1, 7,298.7) = 6.425, p = .011, d = 0.06$). This means that with increased stress the alcohol consumption also rises in individuals with a risk of alcohol addiction. This effect is visible in Figure 11 and did not occur in individuals without the risk of alcohol addiction. The interactions between state loneliness and risk of alcohol addiction do not show a significant effect on the consumption of alcohol ($F(1, 7,298.7) = 3.139, p = .076$). The p-value indicates a trend to increased alcohol intake with higher feelings of loneliness in the risk group of alcohol addiction. Figure 12 illustrates this trend.

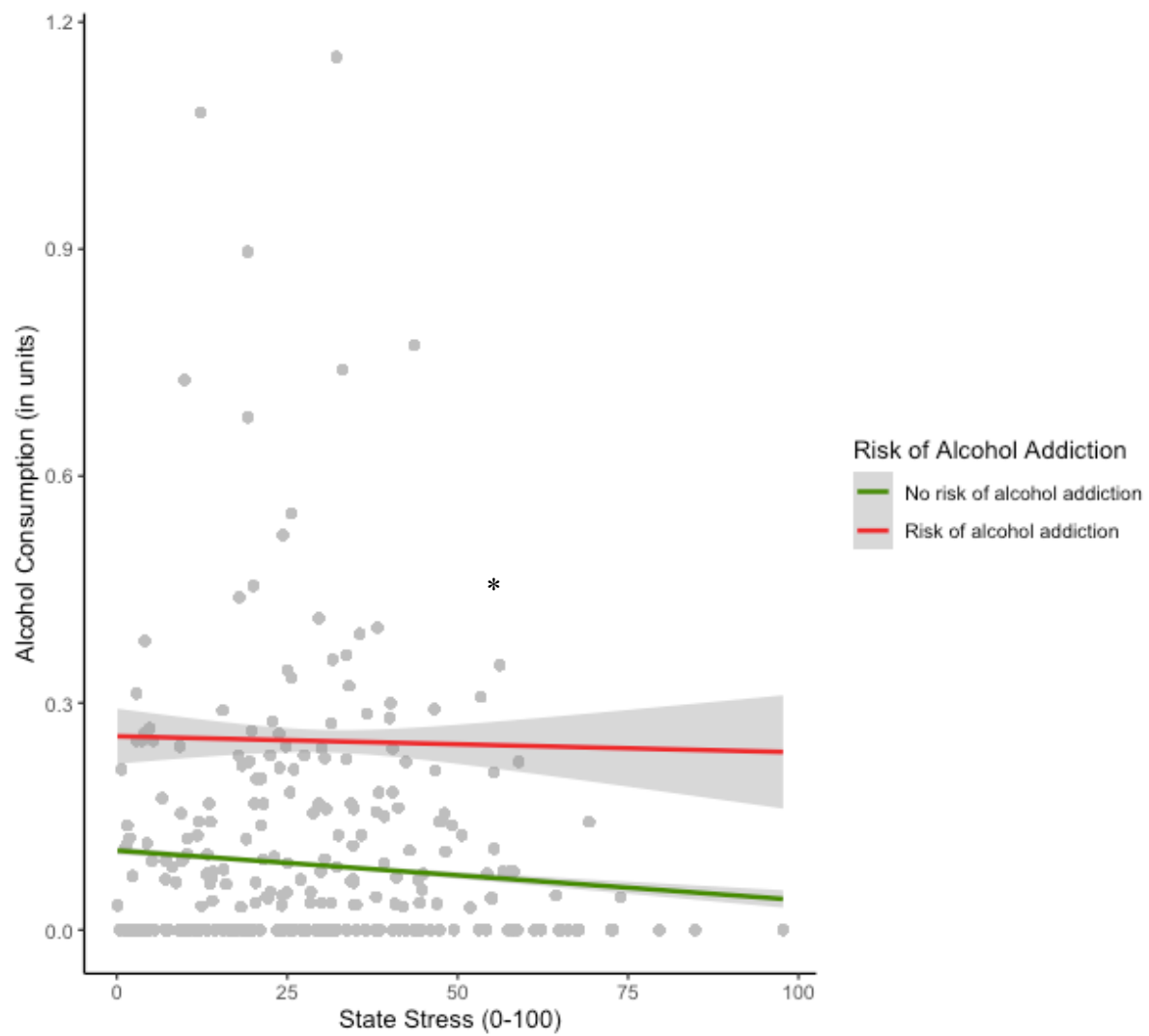
Table 6

Results of the Exploratory Analysis (Linear Mixed Model Fit by REML^a in RStudio)

<i>ALCOHOL CONSUMPTION (IN UNITS)</i>			
Fixed Effects			
<i>Predictors</i>	<i>Estimates</i>	<i>CI</i>	<i>p</i>
(Intercept)	0.10	0.09 – 0.12	<.001
Risk of alcohol addiction	0.16	0.11 – 0.22	<.001
<i>Interactions^b:</i>			
State loneliness * Risk of alcohol addiction	-1.62*10 ⁻³	-0.00 – 0.00	.076
State stress * Risk of alcohol addiction	-2.03*10 ⁻³	-0.00 – -0.00	.011
Random Effects			
σ^2	0.21		
$\tau_{00 \text{ subj}}$	0.02		
ICC	0.07		
N _{subj}	283		
Observations	7,589		
Marginal R ² / Conditional R ²	0.023 / 0.095		

Note. Analyses were carried out with RStudio. *T*-tests use Satterthwaite's method. All Predictors have been centered. Within-subject variables (state loneliness, state stress) have been participant mean centered, between-subject variable (risk of alcohol addiction) has been grand mean centered. ^a REML criterion at convergence: 10,188.8.

^b Interactions are marked with *.

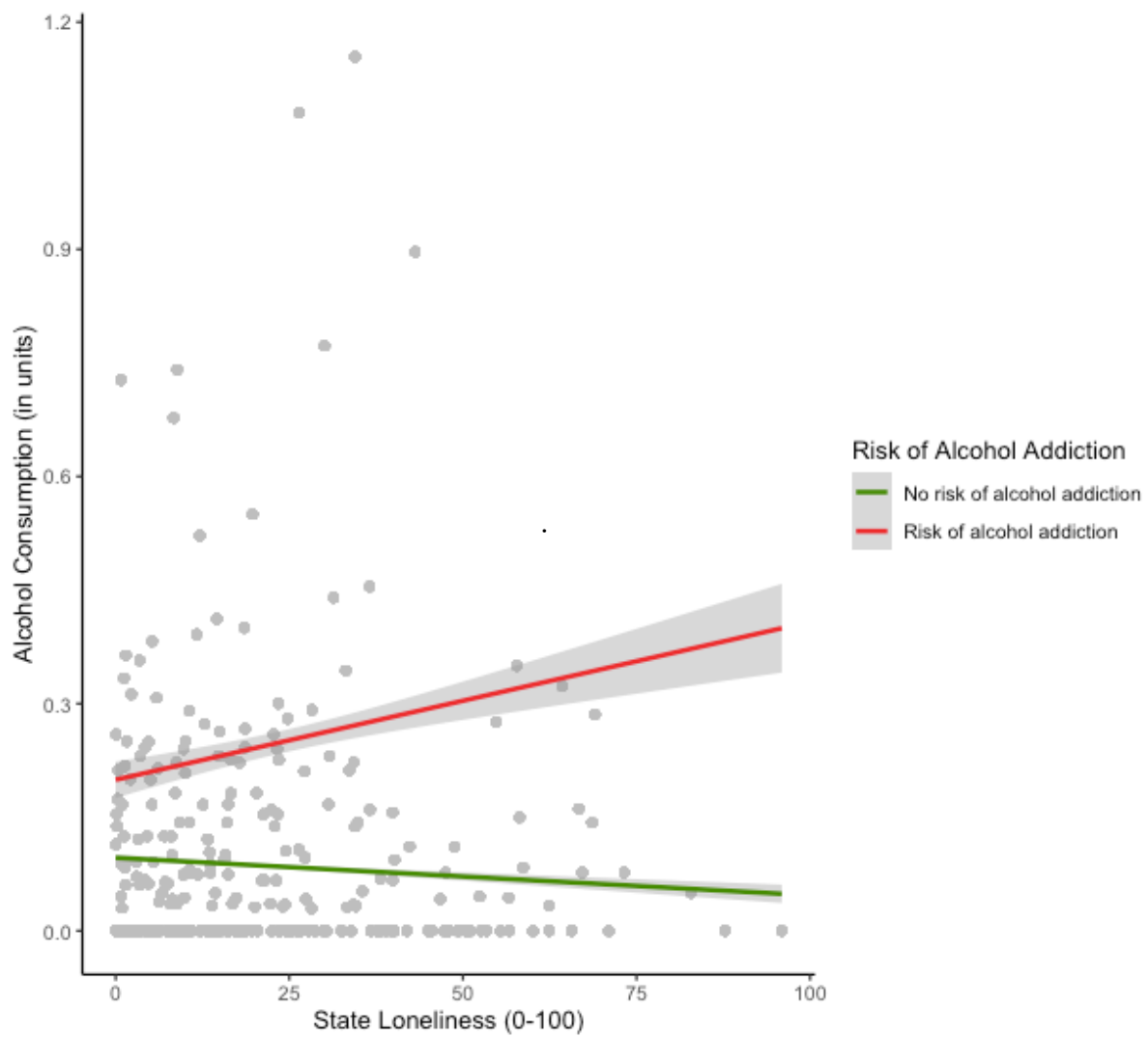
Figure 11*State Stress, Risk of Alcohol Addiction, and Alcohol Consumption*

Note. State stress and alcohol units were aggregated per participant. Each point represents one participant.

* $p \leq .05$

Figure 12

State Loneliness, Risk of Alcohol Addiction, and Alcohol Consumption



Note. State loneliness and alcohol units were aggregated per participant. Each point represents one participant.

. trend

11 Discussion

The aim of the present study is to investigate the impact of risk factors on the effect of state loneliness and state stress on alcohol consumption. The study builds on literature in clinical and health psychology, which links higher stress and loneliness levels to higher alcohol consumption. This research aims to close research gaps with regards to healthy participants in daily life, to the investigation of risk factors as predictors for alcohol consumption and the impact of daily variation.

I addressed this knowledge gap by conducting a non-clinical study, which means that I could avoid an experiment in a laboratory setting and was able to facilitate a natural setting in daily life with the EMA method. The sample mostly consists of individuals without alcohol problems (88.7%). This allows us to check if the same interaction of stress and loneliness on alcohol consumption can be found in a non-clinical sample. It should also be noted that the average age of this sample ($M = 34.16$) is rather young, enabling us to investigate effects of loneliness in younger participants than in usual loneliness studies (Canham et al., 2016; Purser, 2020). The MLM analyses allows us to investigate the main effect (influence from independent variables on the dependent variable) as well as the effect of the cross-level interaction between possible risk factors and independent variables on the dependent variable.

11.1 Summary and Interpretation of the Results

To summarize and interpret the results and answer the research questions, I will address each research question separately.

11.1.1 Research Question 1

Does a higher level of momentary loneliness lead to more alcohol consumption?

State loneliness is not a predictor for alcohol intake in this sample (see Scatterplot in Appendix B. 19.1), which means that H1 could not be proven correct. It must be emphasized that the consumption of alcohol units and loneliness on average was extremely low. More than 40% of all entries in the EMA for loneliness were zeros. An entry of a zero means that a participant was not feeling lonely at all. This data might not contain enough information and variance to make a statement about this research question that would be representative for a population.

Previous studies, which confirm the hypothesis that loneliness and alcohol consumption are related, used samples with different characteristics than the present one. Boulze-Launay

and Rigaud (2020), Åkerlind and Hörnquist (1989) and Medora and Woodward (1991) conducted loneliness studies in clinical alcoholics. The sample of the present study consists of 44.5% participants who did not consume any alcohol during these seven days and only 11.3% of participants who reported having a risk of an alcohol addiction. This leads me to believe that the amount of alcohol consumption and the risk for an existing clinical alcohol addiction differ from a healthy population without alcohol problems when it comes to effects of loneliness on alcohol intake (see 11.1.8).

Canham et al. (2016) and Purser (2020) conducted studies with non-clinical samples and reported an influence of loneliness on alcohol intake, which could not be replicated in the present study. It should be noted that these studies focused on older generations and conclusively the samples had a higher average age (Canham et al: $M = 64.93$, $SD = 0.48$; Purser: $M = 73$, $SD = 7.51$), than the present study ($M = 34.16$, $SD = 13.10$). The big age difference might explain the outcome of this study, as it is possible that this effect is only visible in older age-groups. Previous research also states that young adults usually drink alcohol in a social gathering (Bollen et al., 2021; Chodkiewicz et al., 2020) and thus not necessarily when they are feeling lonely, whereas the elderly also report consuming alcohol alone (Purser, 2020).

11.1.2 Research Question 2

Does a higher level of momentary stress lead to more alcohol consumption?

The same issue (low level of alcohol consumption) appeared when investigating the influence of state stress on alcohol consumption. Still, state stress showed a significant effect on alcohol consumption, indicating opposite results as suspected in H2. The higher momentary stress was reported, the less alcohol was consumed (at least in individuals without a risk for alcohol problems, see 11.1.8). Thus, lower stress predicts higher alcohol intake (Figure 5), which means H2 was refuted. However, the effect size demonstrates a very small effect. This implies that these results with the present data are not representative for a broad population. The reason for this could be that state stress is very low and therefore does not provide enough information.

Clay and Parker (2018) established that stress increases stress-induced drinking in social drinkers. The sample in their research is similar to the present sample (participants are younger with a mean age of 23.92 ($SD = 4.90$)). In their sample, average alcohol consumption

per week was on average higher with 17.95 units⁴ and 2.87 drinks per week, which allows a better interpretation and bigger effect size. It should also be noted that Clay and Parker (2018) used physiological stress measures with heart rate and inter-beat interval and additionally induced social stress with the TSST, while the present study focused on perceived and self-reported stress. The different measures might explain the different outcomes.

Other studies (Chen & Feeley, 2015; Dawson et al., 2005) focused on the impact of stress on heavy drinking or binge-drinking. They found an increase of excessive stress-induced drinking. Low average alcohol intake in the present sample indicates no such drinking behavior overall. Therefore, no effect of stress in relation to heavy drinking or binge-drinking could be found. Ayer et al. (2011) found that stress predicts a higher alcohol consumption in men, but not in women. The present sample consists mostly of women (79%) who also reported higher average stress than men (see 10.1.2). Appendix B.19.2 illustrates possible gender and age differences in this effect, which were not statically analyzed within the framework of this thesis. Descriptive statistics show an interesting trend indicating gender differences that could be analyzed in further studies.

Thus, low amount of alcohol intake, low feelings of stress, self-report measures and uneven gender distribution might explain why H2 was disproven, and why this sample shows the opposite effect as hypothesized.

11.1.3 Research Question 3

Does the effect of state loneliness on alcohol consumption depend on the living condition (living alone or with someone else)?

The interaction of state loneliness and living alone does not have a significant effect on alcohol consumption, which disproves H3 (see Appendix B. 19.6). Previous research indicates that people who are living alone show higher level of loneliness (Klinenberg, 2016; Smith & Victor, 2019), which was not specifically investigated in the present study. As the answer to research question 1 (11.1.1) shows, state loneliness does not have an influence on alcohol consumption. Consequently, the (non-existing) effect of state loneliness on alcohol consumption did not depend on the living condition. The living condition itself appears to have no effect on the consumption of alcohol either. This indicates that living alone is not a risk factor for higher

⁴ Clay and Parker used a different system for alcohol units: “single shot of spirits = 1 unit, Alcopop = 1.5 units, small glass of wine 1.5 units, large glass of wine = 3 units, bottle of beer/cider = 1.7 units, can of beer/cider = 2 units, pint of lower strength beer/cider = 2 units and pint of higher-strength beer/cider = 3 units” (Clay & Parker, 2018, p. 3245). 17.95 units in our system would still be roughly around 6 alcohol units per week.

alcohol intake, which was also not expected. No previous research indicated an effect of living alone on alcohol consumption, but only with living alone, feelings of loneliness, self-harm, depression and suicide (Häfner et al., 2012; Shaw et al., 2021).

11.1.4 Research Question 4

Does the effect of state stress and state loneliness on alcohol consumption depend on depressive symptoms?

Neither H4 nor H5 could be confirmed. The effect of state loneliness on alcohol consumption did not depend on the severity of depressive symptoms (see Appendix B. 19.3), as there was no effect found. Previous studies indicate a strong connection between loneliness, depression and depressive symptoms (Cacioppo et al., 2006; Donovan et al., 2017; Wilson et al., 2007; Yang, 2019). Therefore, the present study did not focus on the relationship between loneliness and depressive symptoms but considered it a given fact.

The effect of state stress on alcohol intake was not modulated by depressive symptoms either (see Appendix B. 19.3), but a higher score in the PHQ-9 predicts higher alcohol consumption. Depressive symptoms were identified as a risk factor for higher alcohol intake (Figure 6). This effect shows a small effect size. This is interesting because previous studies suggest a strong connection between stress and depressive symptoms (Newhouse & Albert, 2015). Wang et al. (2005) even identified work stress as a risk factor for major depressive episodes. The relationship of stress and depressive symptoms was not specifically analyzed in this study as it is a very well researched topic. It is also known that burnout is related to high stress levels in combination with depressive episodes (ICD-10 Code Z73.0, World Health Organization, 1993). However, the outcome shows that low stress and high depressive symptoms predict higher alcohol intake, which indicates no co-occurrence between stress and depressive symptoms. Again, this could be due to low levels of stress overall and other reasons named above in chapter 11.1.2.

Several studies support the finding of the present study that depressive symptoms influences alcohol intake (Bravo et al., 2018). Boden and Fergusson (2011) and Foulds (2015) investigated this relationship in individuals with alcohol use disorder and alcohol dependence. Brook et al. (2002) reported that early alcohol consumption predicts major depressive disorder in later life as well as alcohol dependence. The meta-analysis of Boden and Fergusson (2011) revealed a causal linkage between alcohol use disorder and major depression. Bravo et al.

(2017) explain the relationship between alcohol consumption and depressive symptoms with drinking to cope motives, meaning that alcohol is consumed to enhance negative feelings.

11.1.5 Research Question 5

Does the effect of state loneliness on alcohol consumption depend on trait loneliness?

This question addresses H6, which could not be proven correct. The effect of state loneliness and alcohol consumption did not depend on trait loneliness (see Appendix B. 19.4). These results can be explained as analysis did not show an effect of state loneliness and alcohol intake. Also, trait loneliness itself could not predict a higher alcohol consumption. The reason for this outcome might be the same as for state loneliness as previous research did not divide into state and trait loneliness. Therefore, the sample characteristic could explain these unexpected outcomes, such as younger age of the present sample, as well as low feelings of loneliness and low alcohol intake (see 11.1.1).

11.1.6 Research Question 6

Does the effect of state stress on alcohol consumption depend on chronic stress?

This question addresses H7. The effect of state stress on alcohol intake was not modulated by chronic stress (see Appendix B. 19.5). Therefore, H7 is refuted. Chronic stress has a significant impact on alcohol consumption, which means that chronic stress is a predictor for alcohol consumption. In this sample, higher PSS-10 scores predict lower alcohol consumption (Figure 7), which means chronic stress cannot be identified as a risk factor for higher alcohol intake. These results could be explained by the characteristics of the sample as already stated in chapter 11.1.2 Compared to previous research our sample consisted of unequal distribution of gender, low amount of alcohol intake, low levels of stress and different measurements of stress. Previous studies did not distinguish between state and chronic stress, therefore the same explanations as in chapter 11.1.2 for state stress apply for chronic stress and its influence on alcohol intake.

11.1.7 Research Question 7

How do stress, loneliness and alcohol consumption vary over the day?

A significant effect of time of the day on alcohol was found. Alcohol consumption increases during the day with the highest level in the evening at the last time point of entry before going to bed (Figure 4). This proves H8a and is consistent with previous research (Jones et al.,

2018). With a medium effect size, these findings show a possible relevance for the broader population.

Daily variation is also a significant predictor for state loneliness, but only with a small effect size. Participants reported an average daily loneliness of 20.22 in the mornings at 10 AM – 11 AM. It then decreases and reaches a low point at the second time point entry (11 AM – 2 PM). Afterwards the feeling of loneliness increases until it reaches a peak in the evening before going to sleep (Figure 8). These results prove H8b and are in line with previous studies (Kleiman et al., 2017), showing the highest level of loneliness in the evening. It is also consistent with the CAR, which shows a high cortisol level after waking up and therefore could impact and explain the feeling of loneliness.

State stress varies significantly over the time of the day with a medium effect size. The stress level was the highest on the second time of entry from 11 AM – 2 PM. The reported stress then decreases until it reaches a low point in the evening before going to bed (Figure 9). This finding proves H8c. Vargas & Lopez-Duran (2020) describe a peak in the mornings, which is similar to these results. These results also align with Yamanaka et al. (2019) findings, that people are feeling more stressed in the mornings than in the evenings.

11.1.8 Additional Interpretation

The exploratory analysis shows that 11.3% of the sample have a risk of alcohol problems. Having this risk increases the intake of alcoholic beverages significantly with a medium effect size (Figure 10). The analysis also indicates a small but significant effect with state stress on alcohol consumption (Figure 11). This means that stress is identified as a risk factor for alcohol consumption in people who have an indicated alcohol problem, which is consistent with previous research (Kolb, 2016; Clay & Parker, 2018). The interaction of the risk group for alcohol addiction and state loneliness does not show a significant effect on alcohol intake, but Figure 12 indicates a trend for this effect.

This trend could be stronger and significant if a sample consists of more individuals with a risk for alcohol problems or with an alcohol addiction. Canham et al. (2016) conducted a study with middle-aged social drinkers and found that in this age-group, loneliness is associated with reduced alcohol intake (see chapter 3.2). This supports the outcome of the present study. The main difference to this study is the characteristics of the participants. Canham's (2016) sample consisted of middle-aged participants only, who reported that they drink alcohol once or twice a week, only in social context, and consumed alcohol in the last three months.

Participants in the present study did not even drink one alcohol unit in a week (averaged). As influence of state loneliness on alcohol consumption has been proven in previous research, I also assume that the present sample consists of social drinkers, which aligns with Canhams (2016) findings. As participants were isolated, due to social distancing, they had no social contacts or at the minimum, less than usual. This might explain why participants drank so little alcohol. Previous research suggests the opposite outcome with alcoholic participants (Boulze-Launay & Rigaud, 2020), which is why the exploratory analysis was conducted. This indicates that social drinkers do not show a higher alcohol intake when they feel lonely, whereas alcoholics report an increased alcohol consumption with higher feelings of loneliness.

As already mentioned, the mean of state stress, state loneliness and especially alcohol consumption was extremely low and therefore did not allow for a statement regarding effects on alcohol consumption. As participants did not report a lot of alcohol consumption, I was wondering if they had wanted to consume alcohol but refrained from doing so. To test for this, I investigated question 1 of state stress in the EMA (*“How strong is your desire to drink alcohol right now?”*, in chapter 9.3.1) and compared the answers to actual alcohol intake (see Histogram in Appendix A. 18.3). I found a low desire to consume alcohol, indicating that participants exhibited consequent behavior. Another possible reason for low alcohol intake is the selected sample. It is conceivable that especially mindful and reflective people take part in psychological studies, who are interested in this field and in their own behavior during a crisis (COVID-19 pandemic). Accordingly, this sample might consist of a lot of people who drink less than average alcohol in general. This study might even have favored this reflective lifestyle. Additionally, participants of this sample already knew the questions from the first study (during the first lockdown). They learned that they must answer more questions if they admitted to drinking alcohol, which could result in drinking less alcohol to avoid further questions. The EMA method might also lead to more reflective behavior; participants possibly felt bad during the first study, when they had to report how much they drink (especially writing a number down physically). All of this could have an influence on the behavior and responsive behavior during this survey.

Several studies indicate an increase in alcohol consumption during the COVID-19 lockdown. Pollard et al. (2020) researched a rise of alcohol consumption in the US, as well as Bollen et al. (2021) in students living in Belgium. There was also a 54% increase in US-national sales of alcoholic beverages in March 2020 (The Nielsen Company, 2020), which suggests that people drank more during the lockdown. The Newspaper *Der Standard* published an article which states that 41% of respondents (56,000 people, including 1,108 Austrians) were drinking

more alcoholic beverages during the COVID-19 pandemic. Forty-three percent admitted to consuming more alcohol when being alone than before the pandemic (Redl, 2020). The results of the present study do not confirm these findings. To address these strong differences, it should be noted that this study was conducted at the beginning (the first week) of the second “hard” lockdown in Austria. It is possible that the impact of the COVID-19 lockdown and COVID-19 worries on daily life is a longer process. If individuals are socially isolated for only a few days, it might take time to show a measurable effect on state loneliness. The changes from office jobs to home office could also, for many, be considered a stress relieve at first before becoming a stressful experience after spending some time at home. The same can be said about COVID-19-worries in general. The seriousness of the situation might need time to be realized. This could explain why in this study most people did not report high levels of loneliness, stress, and alcohol consumption. I must emphasize that this is only an assumption, which is not supported by research. It is known however that experiencing critical situations (in this case a COVID-19 lockdown or quarantine) shows time-delayed responses in moods and behavior. It could be similar to PTSS. PTSS mostly occur more than a month after the triggering experience. It is one of the key symptoms of post-traumatic stress disorder (PTSD) to show delayed reactions (World Health Organization, 1993, col. F43.1 post-traumatic stress disorder), which could be comparable to reactions to a global pandemic. High levels of PTSS have been found in healthcare workers in Italy during the strict COVID-19 quarantine and high numbers of infected individuals in intensive cares stations (Di Tella et al., 2020). Studies also show that some individuals who suffered from a serious COVID-19 infection or lost close family or friends due to COVID-19, meet the criteria of a PTSD (Tucker & Czapla, 2021). Bonichini & Tremolada (2021) investigated the quality of life and PTSD symptoms in 1,839 Italians during and after the strict quarantine in Italy in April 2020. They used the Impact of Event Scale- revised (IES-r) to measure PTSS. Around 23.5% of all participants reported a clinical score. These studies indicate PTSS, which characteristically occurs with a late-onset, as a result of the global COVID-19 pandemic.

11.2 Advantages, Limitations and Outlook for further research

There are many advantages to the EMA method, including real-time measurements in daily life and a natural setting. However, this is only possible by implementing self-reporting measurements, which is vulnerable to receiving answers that could be attributed to social desirability and whitewashing tendencies. EMA measures at five time-points a day, so it can be

tiring for participants to answer the same questions multiple times a day for a week. This could lead to untrue answers. Additionally, if participants replied that they consumed alcohol since the last entry, they will get two additional questions to answer regarding the amount and liking of the alcohol beverage. This might discourage respondents from answering truthfully. It is also possible that participants did not answer the questionnaire correctly when intoxicated by alcohol. Maybe individuals actually did drink an alcoholic beverage, but then skipped the alarm entry and therefore it was not reported. This is a possibility as most participants did not answer 100% of the EMA⁵. In conclusion, the EMA has a lot of advantages which can only coexist with some disadvantages. It should also be noted that movisensXS only works with Android phones. This excludes mobile phone users with other operating systems. It would be advised for following studies to use measures that require less effort. This might lead to more answered prompts in general and increase the chance of an intoxicated person managing to respond, even though they consumed a considerable amount of alcohol. This measurement could also include physical measures like a breathalyzer (alcohol tester).

As already stated above, the sample did not drink enough alcohol to make a statement about some Hypotheses, this is a clear implication of the study. A bigger impact might be found with a clinical sample of alcoholics or at least not so many non-drinkers, as the exploratory analysis shows that people with a risk of alcohol problems show a significant effect with state stress on alcohol consumption. This effect might increase in a clinical sample.

Thus, for further research it would be interesting to conduct the same study with alcoholics, which would probably lead to more significance and significant results regarding alcohol consumption. It might be useful to select a sample, making sure that participants drink alcoholic beverages regularly in general, in order to have informative data. Higher alcohol consumption might also lead to an outcome for the influence of state loneliness on alcohol consumption and dependencies of underlying risk factors.

As this study was conducted during the first weeks of the second lockdown, it would be interesting to conduct a similar study in later stages of a lockdown (in case of another lockdown). The worries about the situation and the mindset might change when being further in a lockdown, as well as levels of loneliness and stress, which could be expected to increase.

Further research can also be done with a sample that consists only of men or with a more even gender distribution, as a previous study (Ayer et al., 2011) indicates that the effect of higher stress on alcohol consumption was only significant in men. Stress level and its

⁵ 30,24% of the EMA alerts were ignored and questions not answered

relation to alcohol consumption might increase in more male or exclusively male participants. The present research shows that participants did not use alcohol-drinking to cope with stress, but further research can investigate alternative coping mechanisms.

11.3 Current relevance of this study

This study identifies depressive symptoms as a risk factor for alcohol consumption. Furthermore, lower state and chronic stress predict higher alcohol consumption in healthy individuals without a risk for alcohol addiction. People with an indicated alcohol problem on the other hand reported to drink more alcohol when they feel stressed. This identifies stress as a risk factor for people who have a risk of alcohol addictions. Also, a trend in higher loneliness predicting alcohol consumption in this group of individuals is visible, but not significant. Especially nowadays with the COVID-19 crisis and situational increased drinking (*Der Standard* article, Palmai, 2021) this thesis is relevant to check which risk factors accelerate this trend. Previous research reported that PTSS have been found in individuals as a result of the global COVID-19 pandemic. Depressive symptoms, stress and feelings of loneliness are symptoms of PTSD, which makes the results of this study all the more important. This thesis identifies risk factors (stress, depressive symptoms and also a trend for loneliness) and risk groups (individuals with an indicated alcohol problem), which should be taken into consideration for prevention and special attention during a crisis like the COVID-19 pandemic.

12 Conclusion

In conclusion, the present study proves a significant impact of depressive symptoms on alcohol consumption. It also shows that loneliness, stress, and alcohol consumption vary significantly over the course of the day. This thesis' findings demonstrate significant daily variations in alcohol consumption and state loneliness, both peaking in the evening; and in state stress, decreasing significantly over the day. In this sample, state stress and chronic stress predict a lower alcohol consumption, which is not in line with previous findings. Exploratory analysis showed that this effect only existed in a group of people without any indication for an alcohol addiction. Moreover, previous research confirms associations between state loneliness and alcohol consumption, which could not be replicated. The results in the present study might not be in line with previous research, because the low levels of alcohol intake, low levels of stress and low levels of loneliness among participants did not allow interpretations with a sufficient effect size. Characteristics of the present sample vary from previous research in

distribution of gender, age, and the amount of alcohol consumption. Therefore, it could not be proven that the effect of state stress and state loneliness on alcohol consumption is dependent on risk factors. But exploratory analysis identified stress as a risk factor for alcohol consumption in people with an indicated alcohol problem. The same trend was found in this group for loneliness and alcohol consumption, but not with a significant effect. Participants who did not show a risk of alcohol addiction showed the opposite effect, which means that higher stress indicated lower alcohol consumption.

It should be emphasized that this study was conducted with the EMA method, and it was thus possible to collect data in a real-time during a natural setting in daily life. This study provides information on loneliness, stress, and depressive symptoms during the COVID-19 lockdown in Austria in a non-clinical setting with a non-clinical sample. It also creates the opportunity for further research and improvements in the sample selection and measures.

13 Abstract

13.1 English Abstract

Previous research indicates an association of loneliness, stress and alcohol consumption and a higher level of all three variables during the COVID-19 pandemic. This study investigates the influence of state loneliness and state stress on alcohol consumption and if this influence is modulated by multiple risk factors. It also analyses the influence of daily variation on loneliness, stress, and alcohol intake. Proposed risk factors include depressive symptoms, trait loneliness, chronic stress, and living alone. I argue that higher scores in state loneliness and state stress predict increased alcohol intake and that this effect depends on risk factors. Data was collected with an ecological momentary assessment (EMA) during the second COVID-19 lockdown in Austria. EMA allows data gathering in daily life and in a natural setting. Participants ($N = 283$) self-reported via movisensXS App five times a day for seven consecutive days. My analysis shows that state and chronic stress predict lower alcohol consumption, while a higher score in depressive symptoms predict higher alcohol intake. Time of the day appears significant for alcohol consumption, state stress and state loneliness. The effect of state stress and state loneliness on alcohol consumption did not depend on risk factors. Additional analysis indicated that people at risk for alcohol addiction consume more alcohol as stress increases. In conclusion, the results verify previous research in regard to loneliness and alcohol consumption peaking in the evening and stress decreasing significantly over the day. Depressive symptoms were identified as a risk factor for higher alcohol consumption and stress as a risk factor for individuals with an indicated alcohol problem.

Keywords: Ecological momentary assessment; stress; loneliness; alcohol consumption; covid-19

13.2 German Abstract

Forschungen deuten auf einen Zusammenhang von Einsamkeit, Stress und Alkoholkonsum hin. Studien zeigen außerdem ein vermehrtes Erleben von Stress und Einsamkeit, sowie höheren Alkoholkonsum während der COVID-19 Pandemie. Die vorliegende Studie untersucht die Auswirkung von aktuell erlebter Einsamkeit und aktuell erlebtem Stress auf den Alkoholkonsum. Es wird zudem der Effekt von mehreren Risikofaktoren auf diese Auswirkung und der Einfluss der Tageszeit analysiert. Zu den Risikofaktoren zählen depressive Symptome, zeitüberdauernde Einsamkeit, chronischer Stress und Alleinleben. Ich behaupte, dass ein erhöhtes Erleben von aktueller Einsamkeit und aktuellem Stress einen höheren Alkoholkonsum vorhersagen und dass dieser Effekt von Risikofaktoren abhängig ist. Die Daten wurden mit einem ecological momentary assessment (EMA) während des zweiten COVID-19 Lockdowns in Österreich erhoben. Die EMA ermöglicht die Datenerhebung im täglichen Leben und in natürlicher Umgebung. Die Teilnehmer*innen ($N = 283$) beantworten über die movisensXS App fünfmal täglich an sieben aufeinanderfolgenden Tagen mehrere Fragen über Konsumverhalten und Stimmung. Meine Analyse zeigt, dass momentaner und chronischer Stress einen geringeren Alkoholkonsum vorhersagen, während stärkere depressive Symptome zu einem erhöhten Alkoholkonsum führen. Zudem variieren Alkoholkonsum, Einsamkeit und Stress signifikant über den Tagesverlauf. Der Einfluss von aktuellem Stresserleben und aktuell erlebter Einsamkeit auf den Alkoholkonsum hängen nicht von den genannten Risikofaktoren ab. Eine weitere Analyse ergab, dass Teilnehmer mit einem Risiko für Alkoholabhängigkeit mit zunehmendem Stress mehr Alkohol konsumierten. Zusammenfassend bestätigen die Ergebnisse frühere Forschungen in Bezug auf Einsamkeit und Alkoholkonsum, welche am Abend den Höhepunkt erreichen, sowie in Bezug auf Stress, welcher über den Tag signifikant abnimmt. Depressive Symptome wurden als Risikofaktor für höheren Alkoholkonsum identifiziert und Stress als ein Risikofaktor für Personen mit einem möglichen Alkoholproblem.

Keywords: Ecological momentary assessment; stress; einsamkeit; alkoholkonsum; covid-19

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15 List of Figures

Figure 1 Change in Drinking Amount and Frequency since before COVID-19.....	16
Figure 2 Participants Divided by Alcohol Consumption.....	27
Figure 3 Participants Divided by Household Condition.....	28
Figure 4 Alcohol Consumption Throughout the Day	30
Figure 5 Main Effect of State Stress on Alcohol Consumption	31
Figure 6 Main Effect of Depressive Symptoms on Alcohol Consumption	32
Figure 7 Main Effect of Chronic Stress on Alcohol Consumption	33
Figure 8 Loneliness Throughout the Day	35
Figure 9 Stress Throughout the Day	37
Figure 10 Main Effect of Risk of Alcohol Addictive Behavior on Alcohol Consumption.....	38
Figure 11 State Stress, Risk of Alcohol Addiction, and Alcohol Consumption.....	40
Figure 12 State Loneliness, Risk of Alcohol Addiction, and Alcohol Consumption.....	41

16 List of Tables

Table 1 Participants Divided in Age-groups	20
Table 2 Questionnaires, Methods, and Measured Constructs	22
Table 3 Results of the Main Effect	29
Table 4 Results of the Effect of Risk Factors on State Loneliness	34
Table 5 Results of the Effect of Risk Factors on State Stress	36
Table 6 Results of the Exploratory Analysis	39

17 List of Abbreviations

EMA – Ecological momentary assessment

WHO – World Health Organization

VAS – visual analogue scale

MLM – Multilevel Model

LMM – Linear Mixed Model

Q-Q plot – Quantile-quantile plot

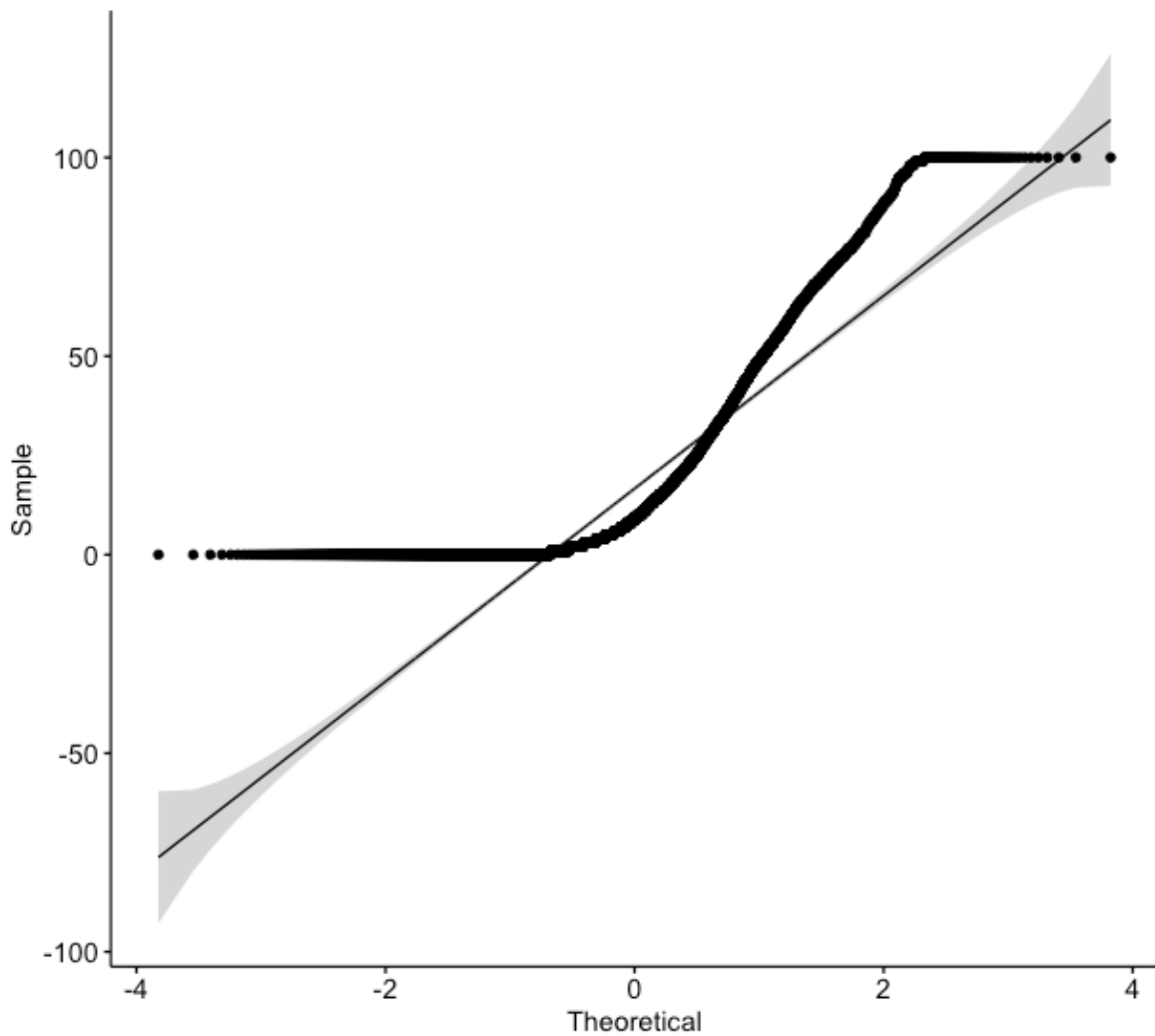
PTSD – Post-traumatic stress disorder

PTSS – Post-traumatic stress symptoms

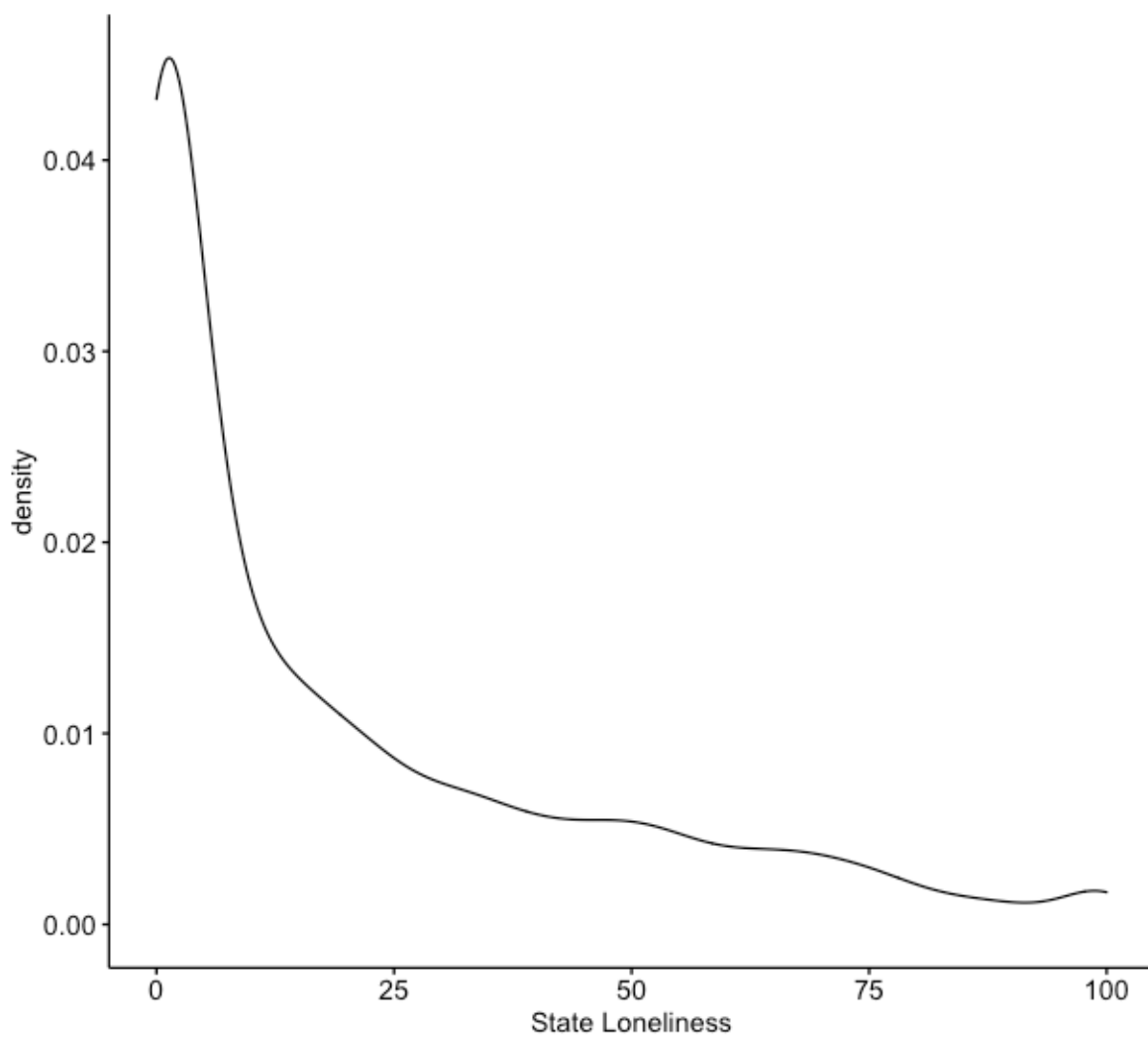
18 Appendix A. Information about Distributions

18.1 State Loneliness

Q-Q plot of State Loneliness



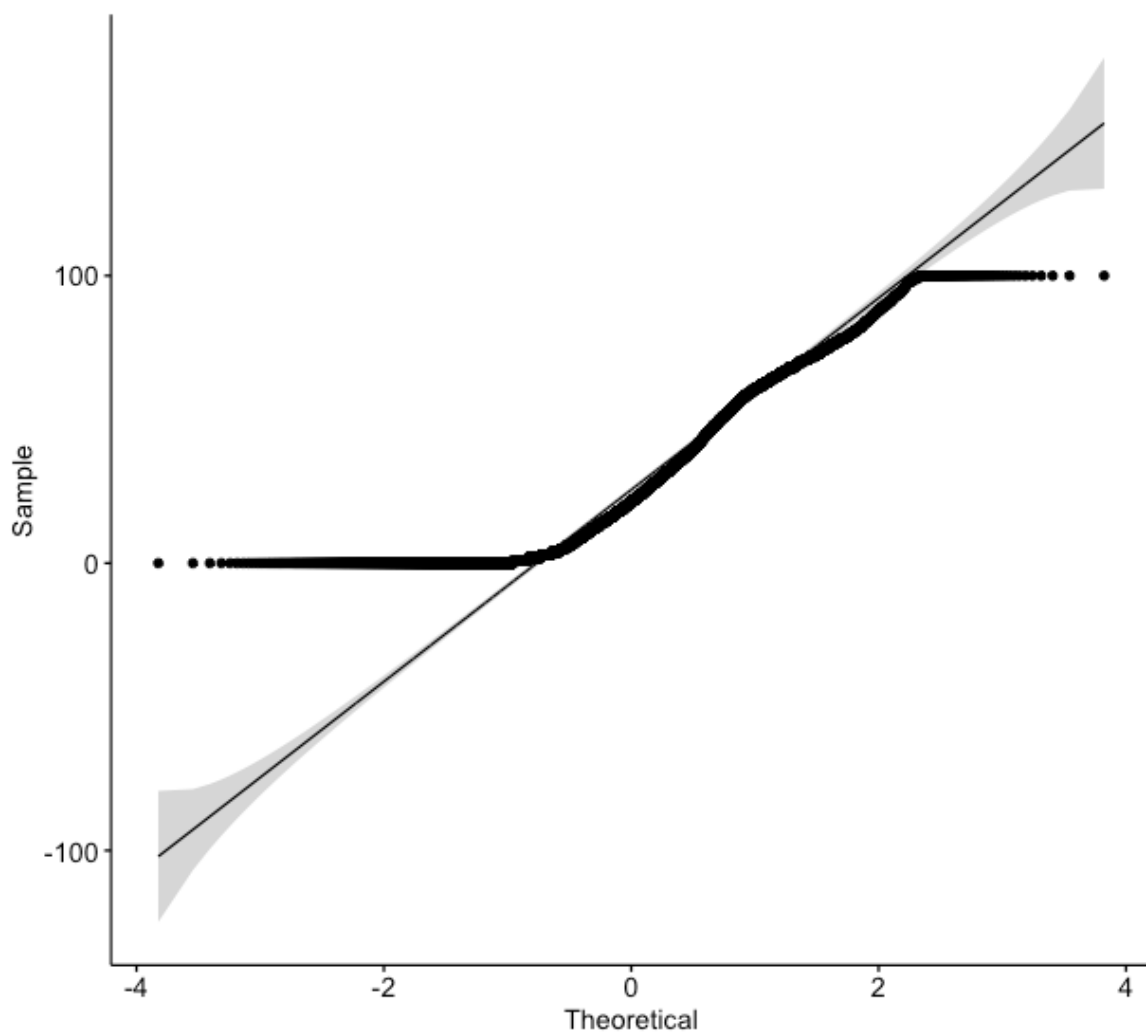
Note. Q-Q plot indicates no normal distribution of state loneliness.

Density Plot of State Loneliness

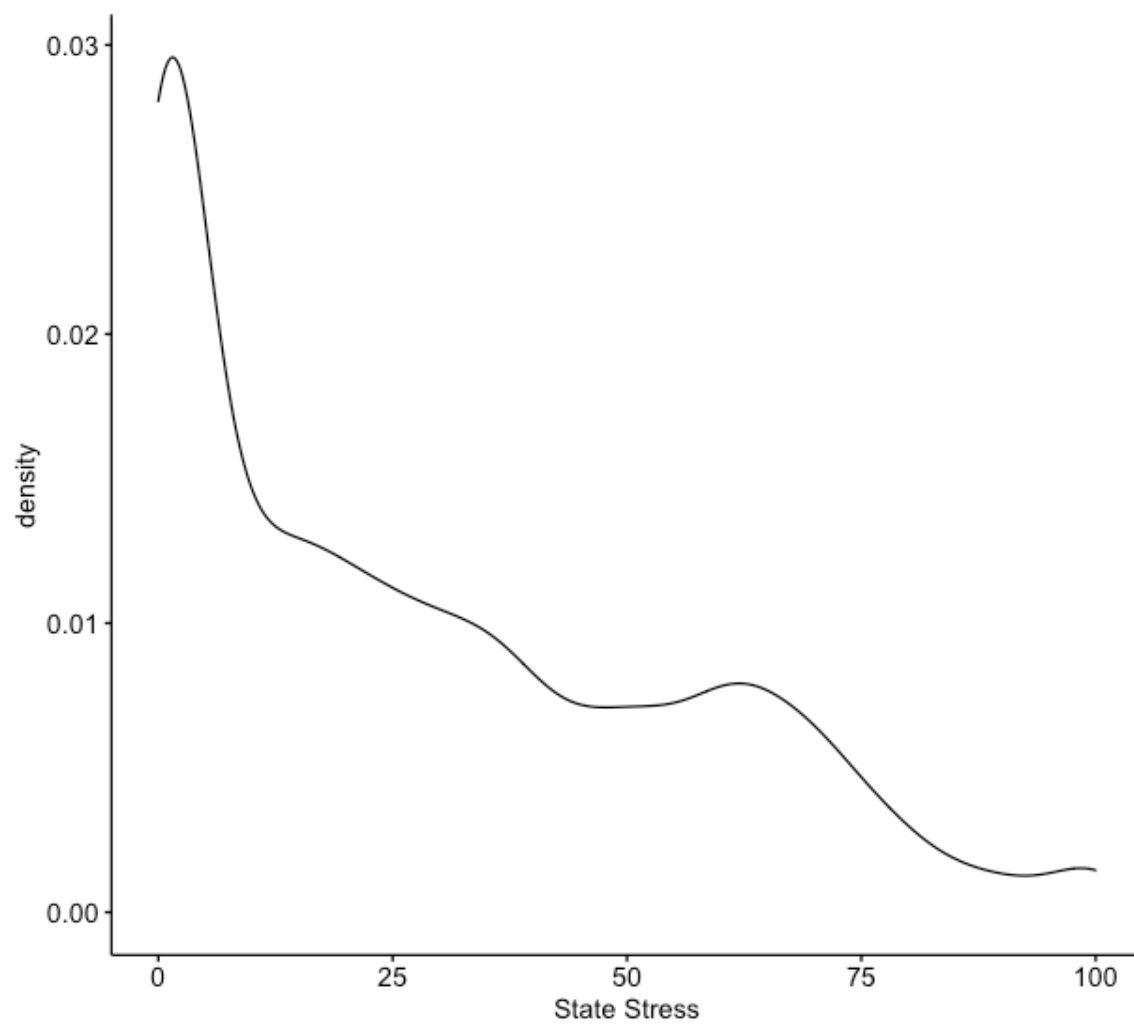
Note. Density plot indicates no normal distribution of state loneliness with a visible high point at 0.

18.2 State Stress

Q-Q plot of State Stress



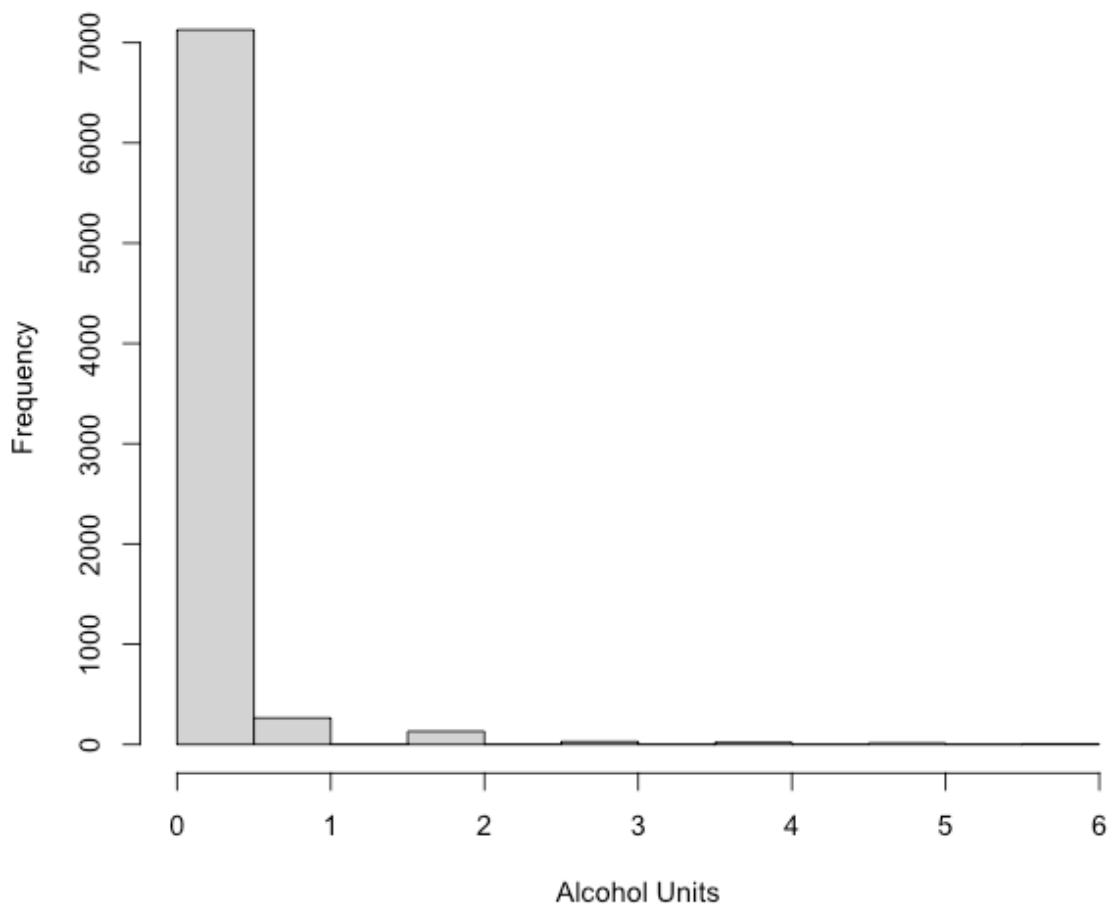
Note. Q-Q plot indicates no normal distribution of state stress.

Density Plot of State Stress

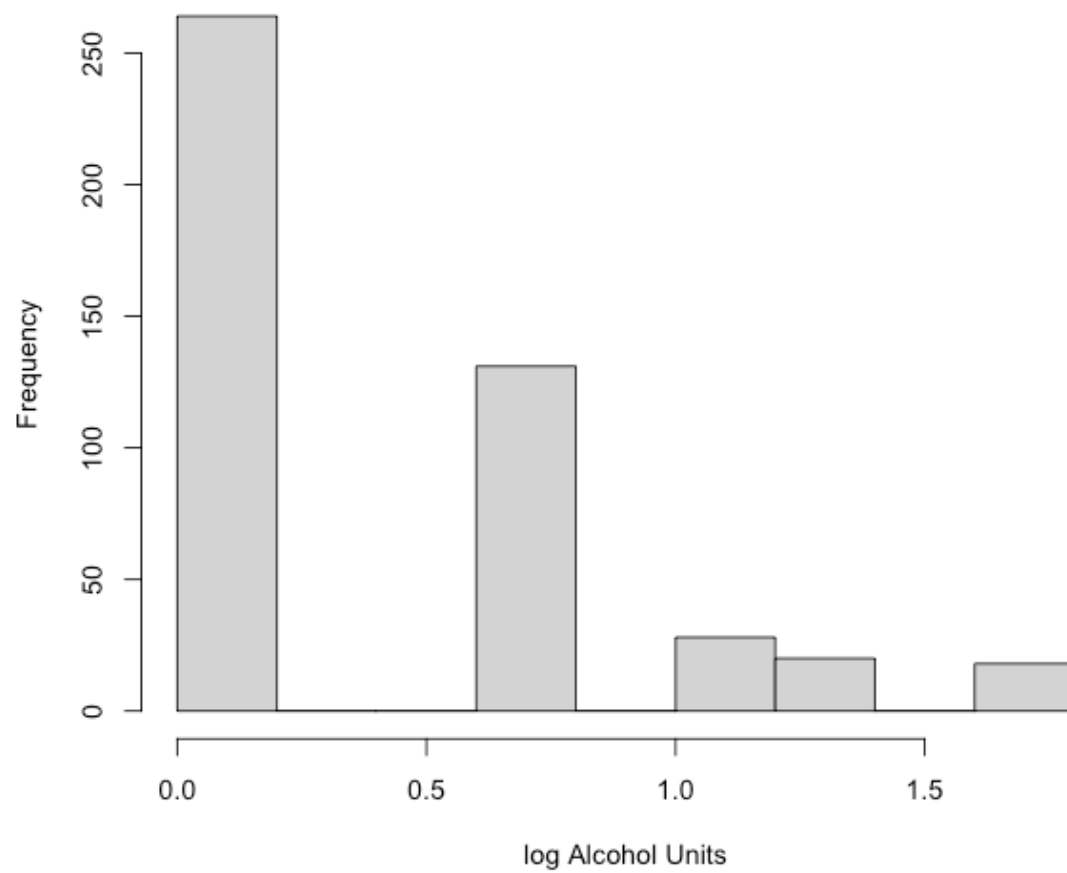
Note. Density plot indicates no normal distribution of state stress with a visible high point close to 0.

18.3 Alcohol Consumption

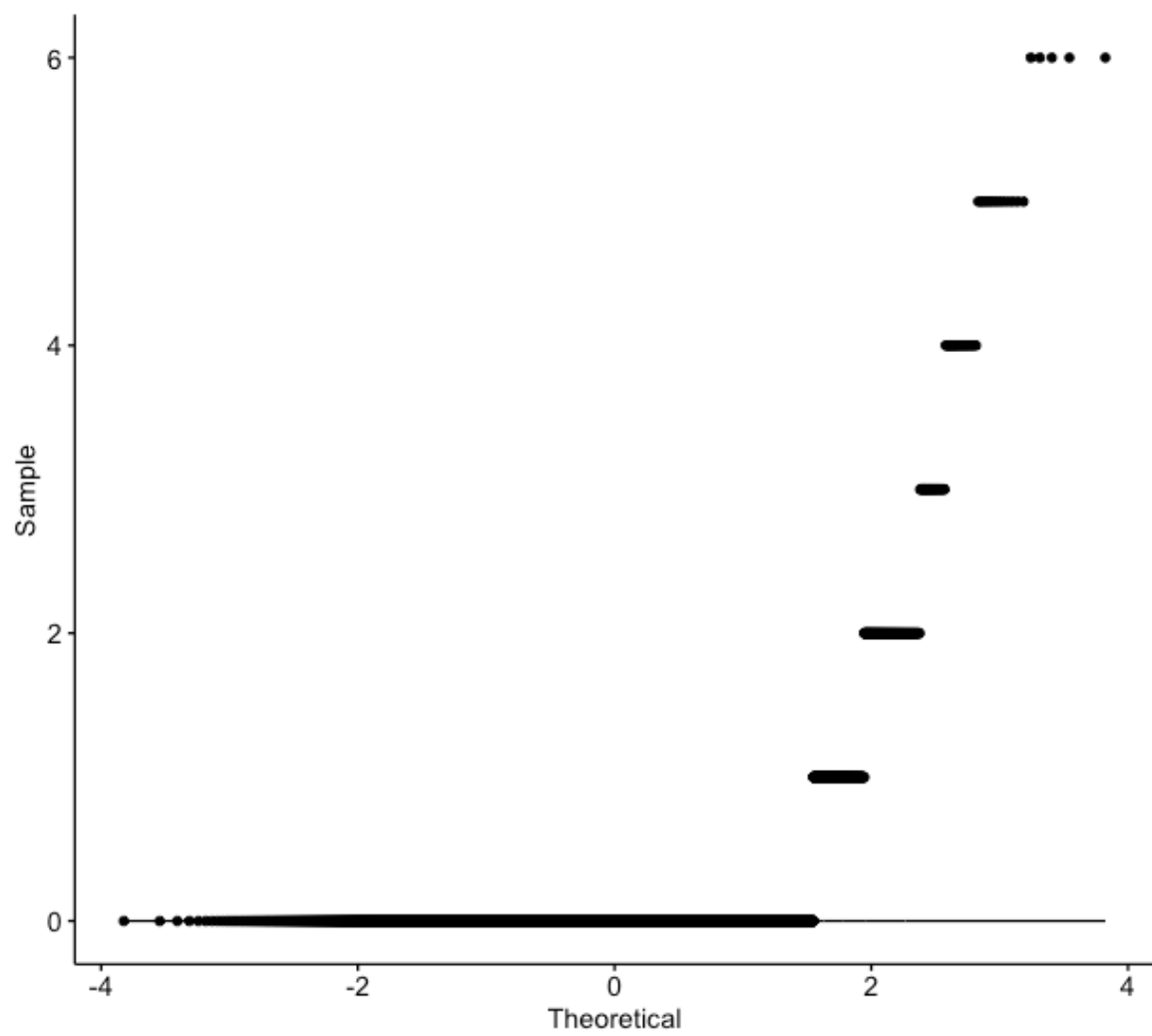
Histogram of Alcohol Units



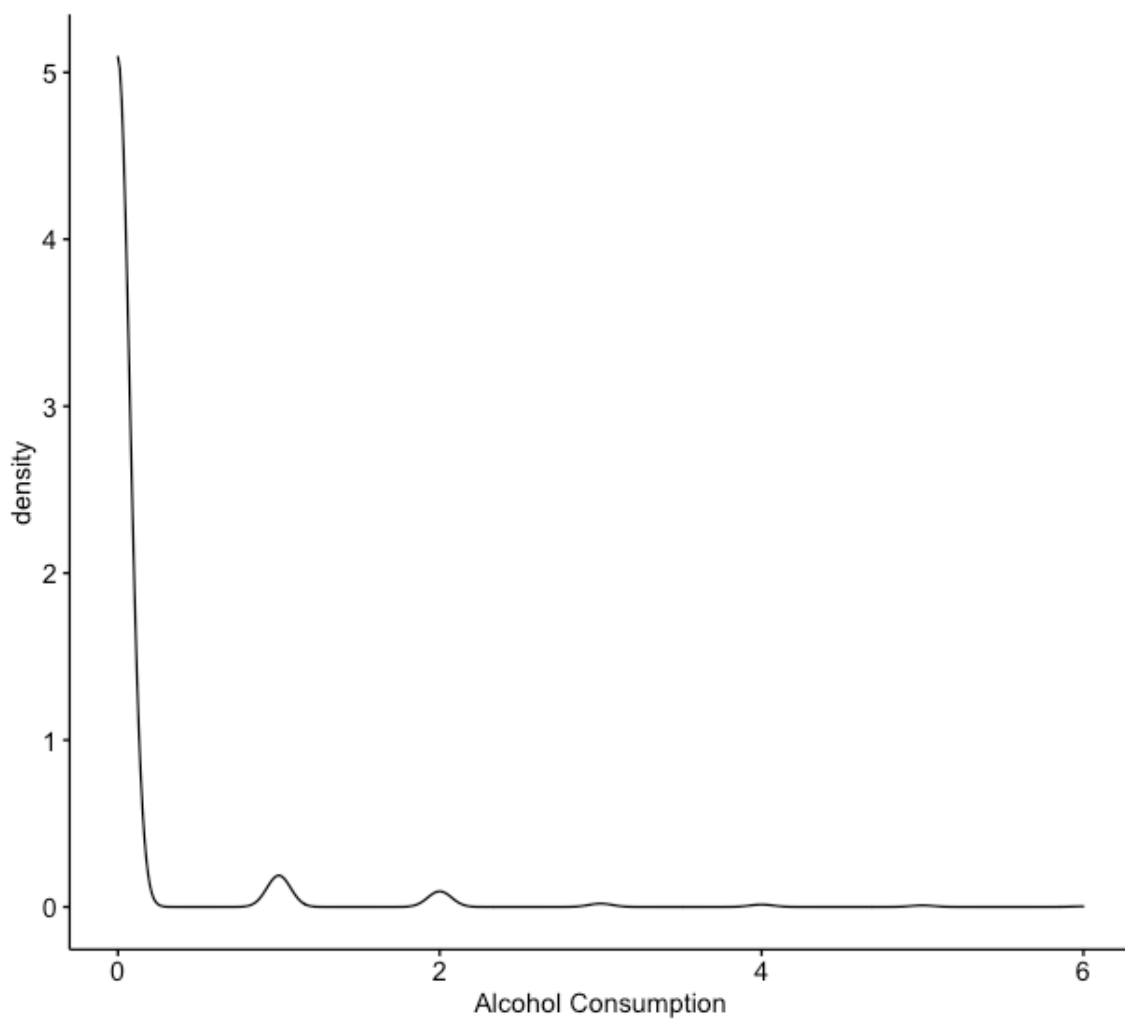
Note. Frequency of alcohol units consumed during the study of all participants.

Histogram of logarithmic transformed Alcohol Units

Note. Logarithm of alcohol units consumed during the study of all participants.

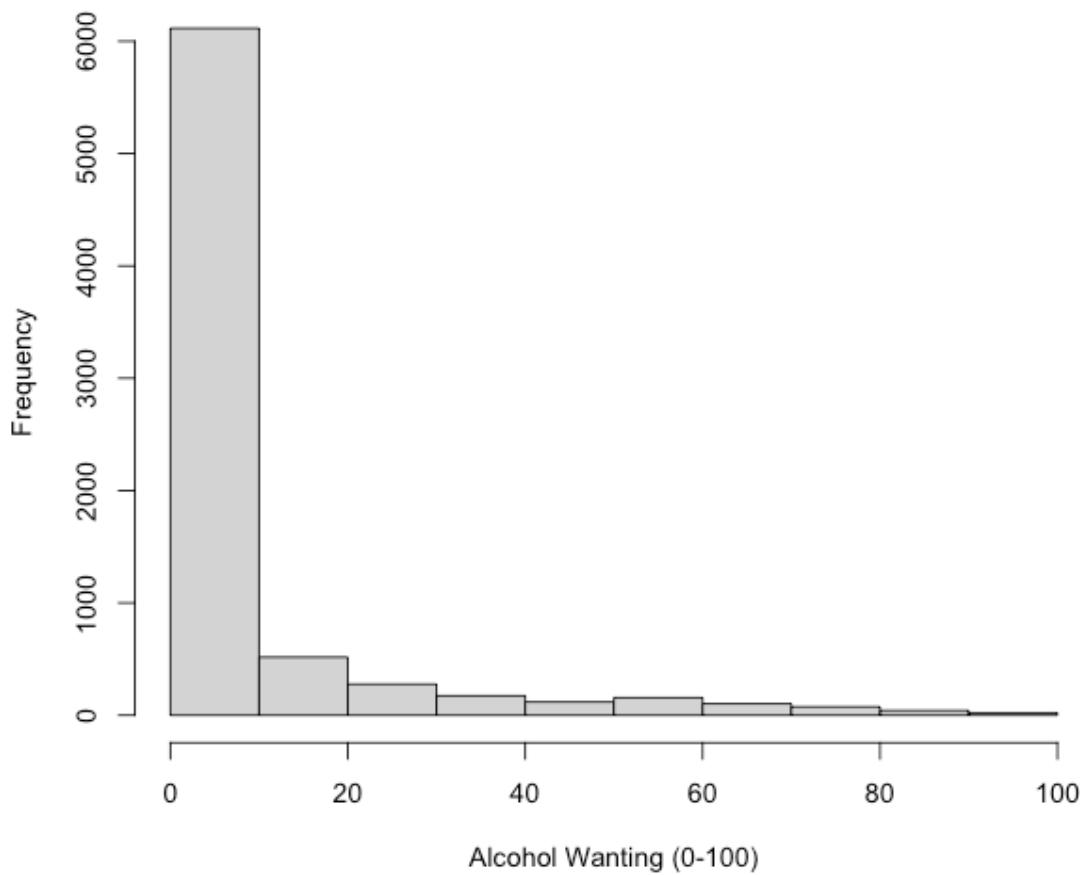
Q-Q plot of Alcohol Units

Note. Q-Q plot indicates no normal distribution of alcohol units.

Density Plot of Alcohol Units

Note. Density plot indicates no normal distribution of alcohol consumption with a visible high point at 0.

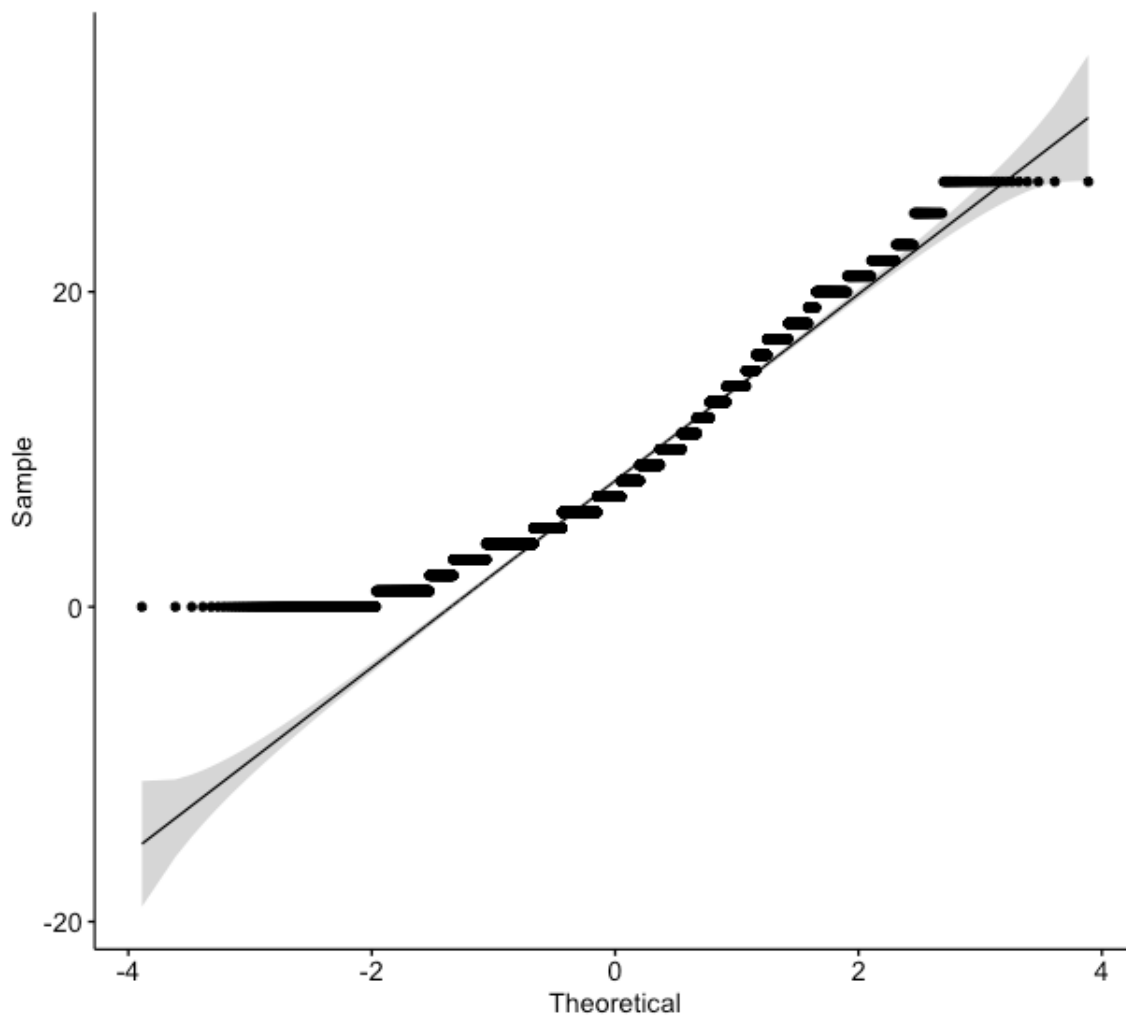
Histogram of Alcohol Wanting



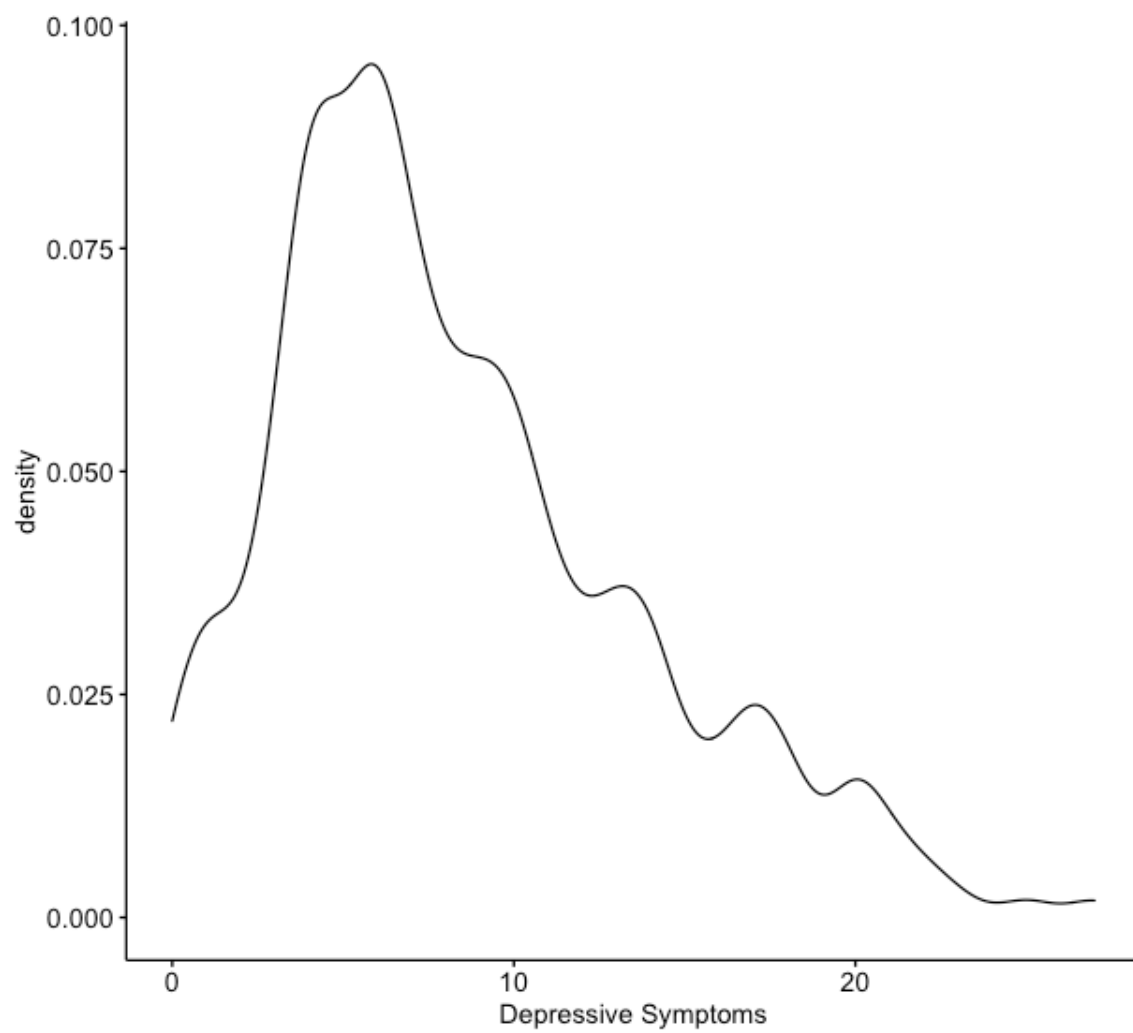
Note. Entries of the desire to drink alcohol from all participants over the whole study.

18.4 Depressive Symptoms

Q-Q plot of Depressive Symptoms



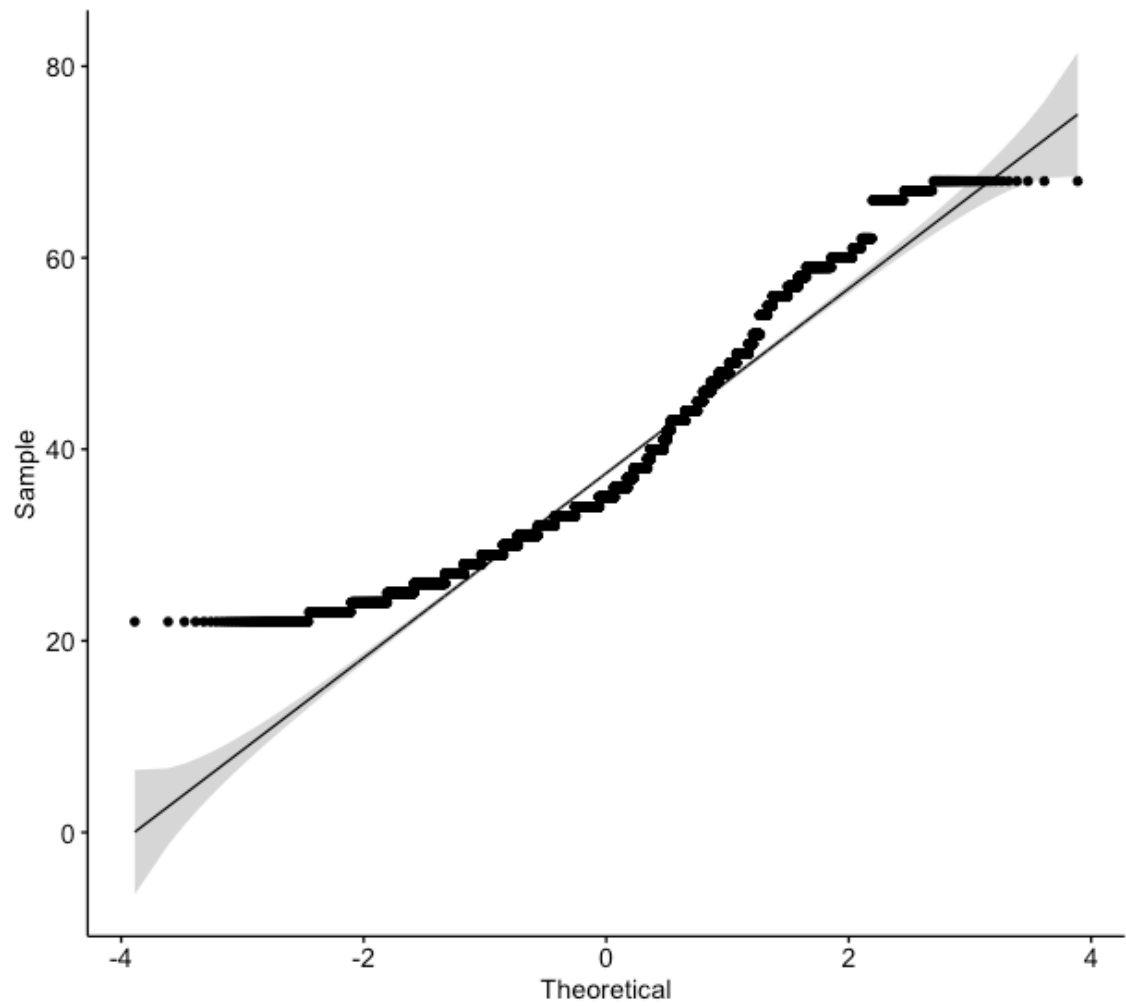
Note. Q-Q plot indicates a normal distribution of depressive symptoms (PHQ-9 scores).

Density Plots of Depressive Symptoms

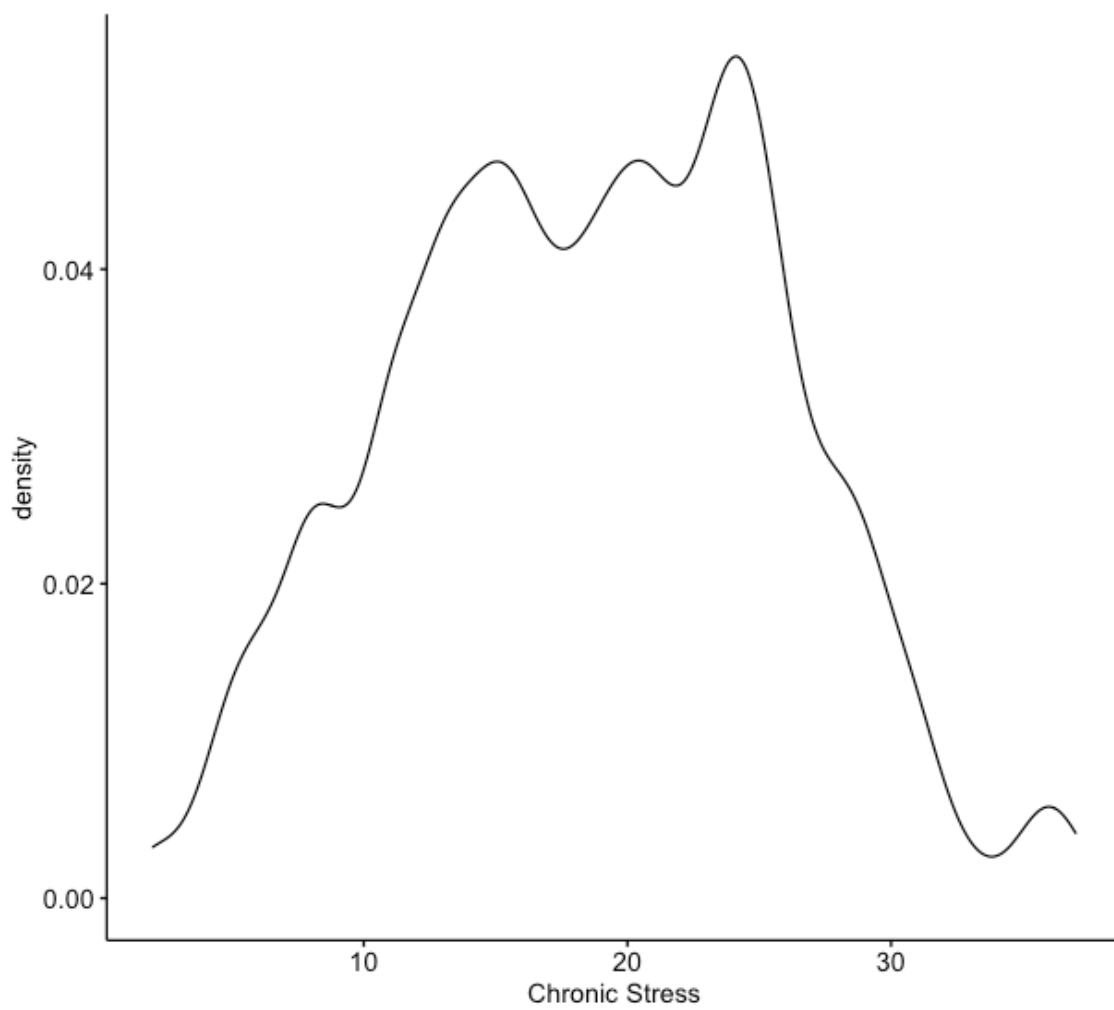
Note. Density plot indicates a normal distribution of depressive symptoms (PHQ-9 scores) with a visible high point at close to 10.

18.5 Chronic Stress

Q-Q plots of Chronic Stress



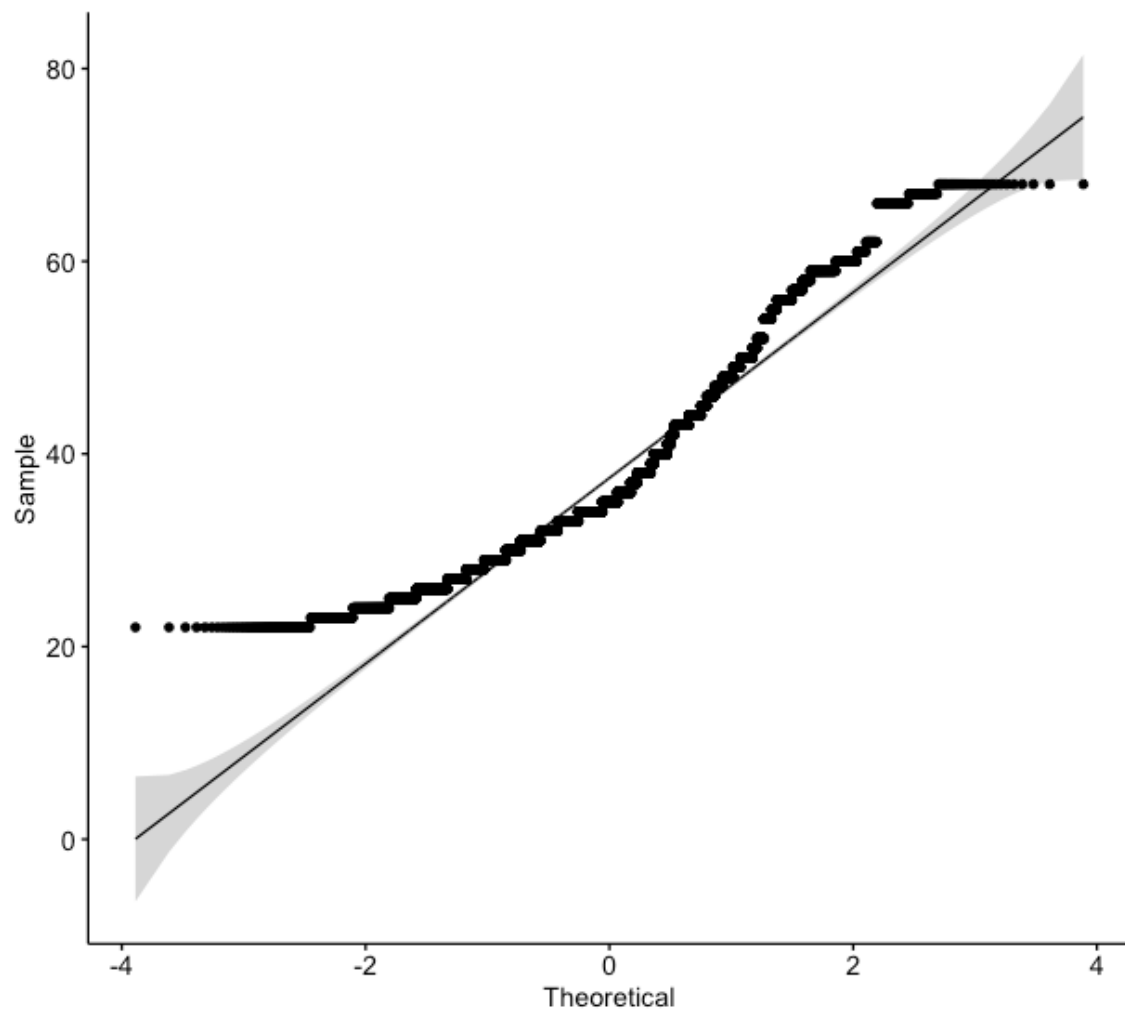
Note. Q-Q plot indicates a normal distribution of chronic stress (PSS-10 scores).

Density Plots of Chronic Stress

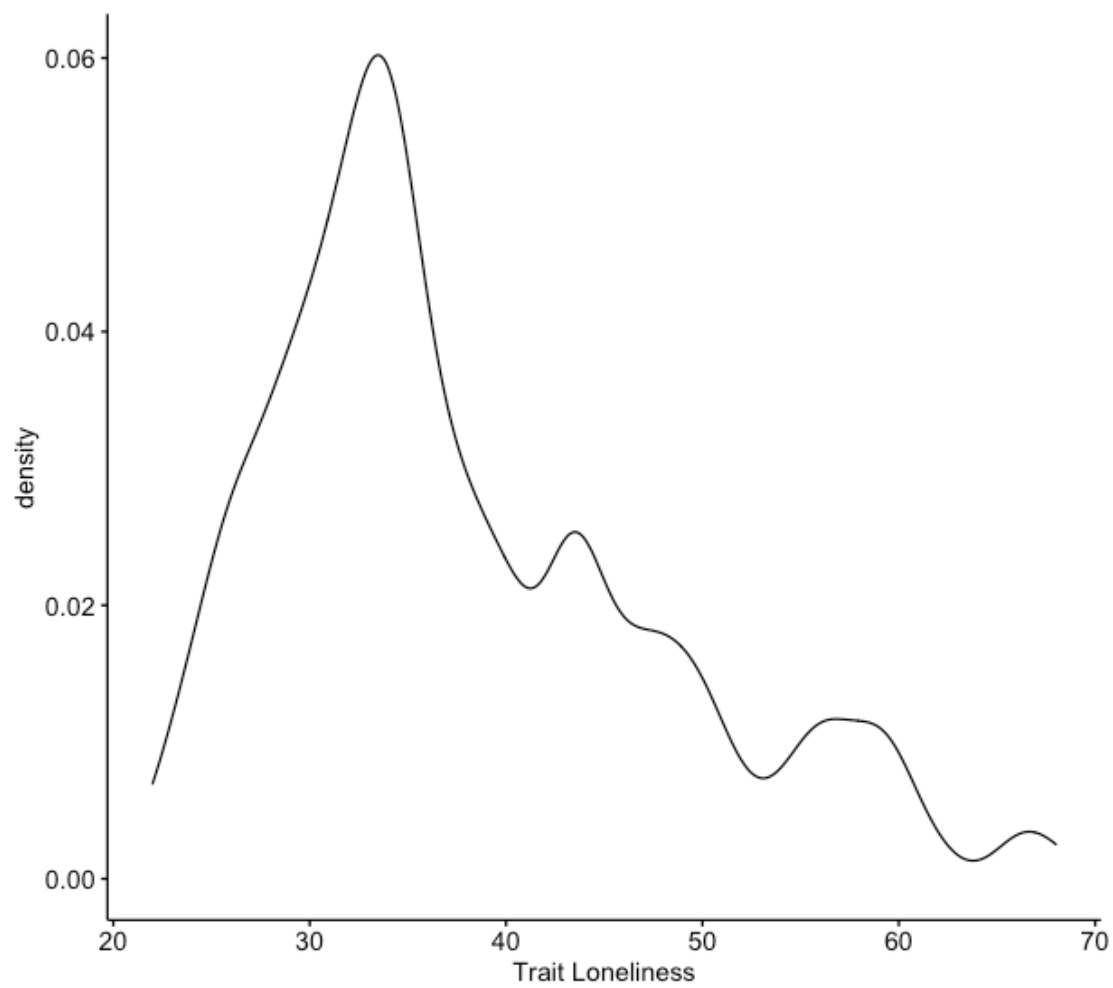
Note. Density plot indicates a normal distribution of chronic stress (PSS-10 scores).

18.6 Trait Loneliness

Q-Q plots of Trait Loneliness



Note. Q-Q plot indicates a normal distribution of trait loneliness (UCLA-LS-3 scores).

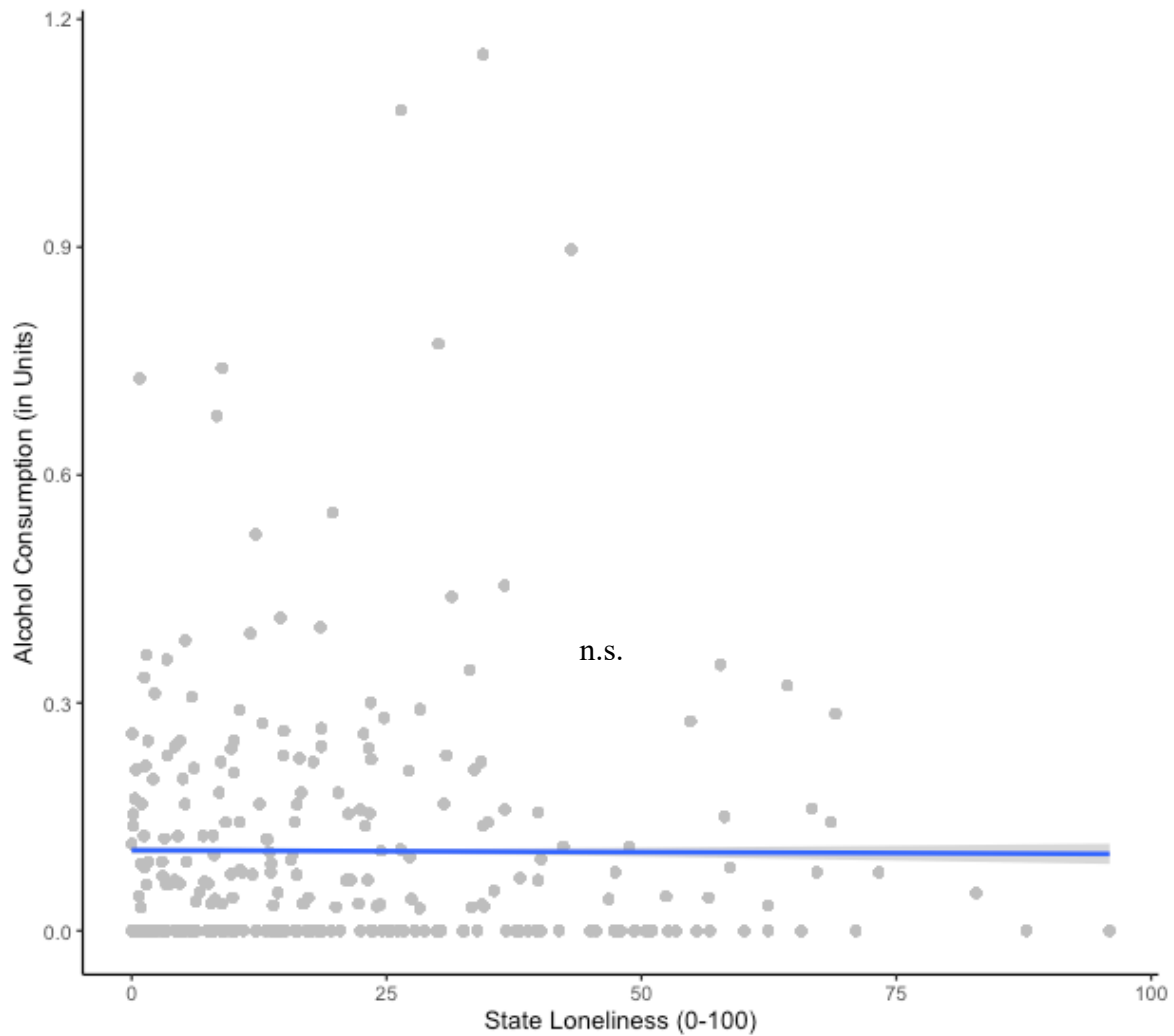
Density Plots of Trait Loneliness

Note. Density plot indicates a normal distribution of trait loneliness (UCLA-LS-3 scores) with a high point at 35.

19 Appendix B. Scatterplots

19.1 State Loneliness

Main Effect of State Loneliness on Alcohol Consumption

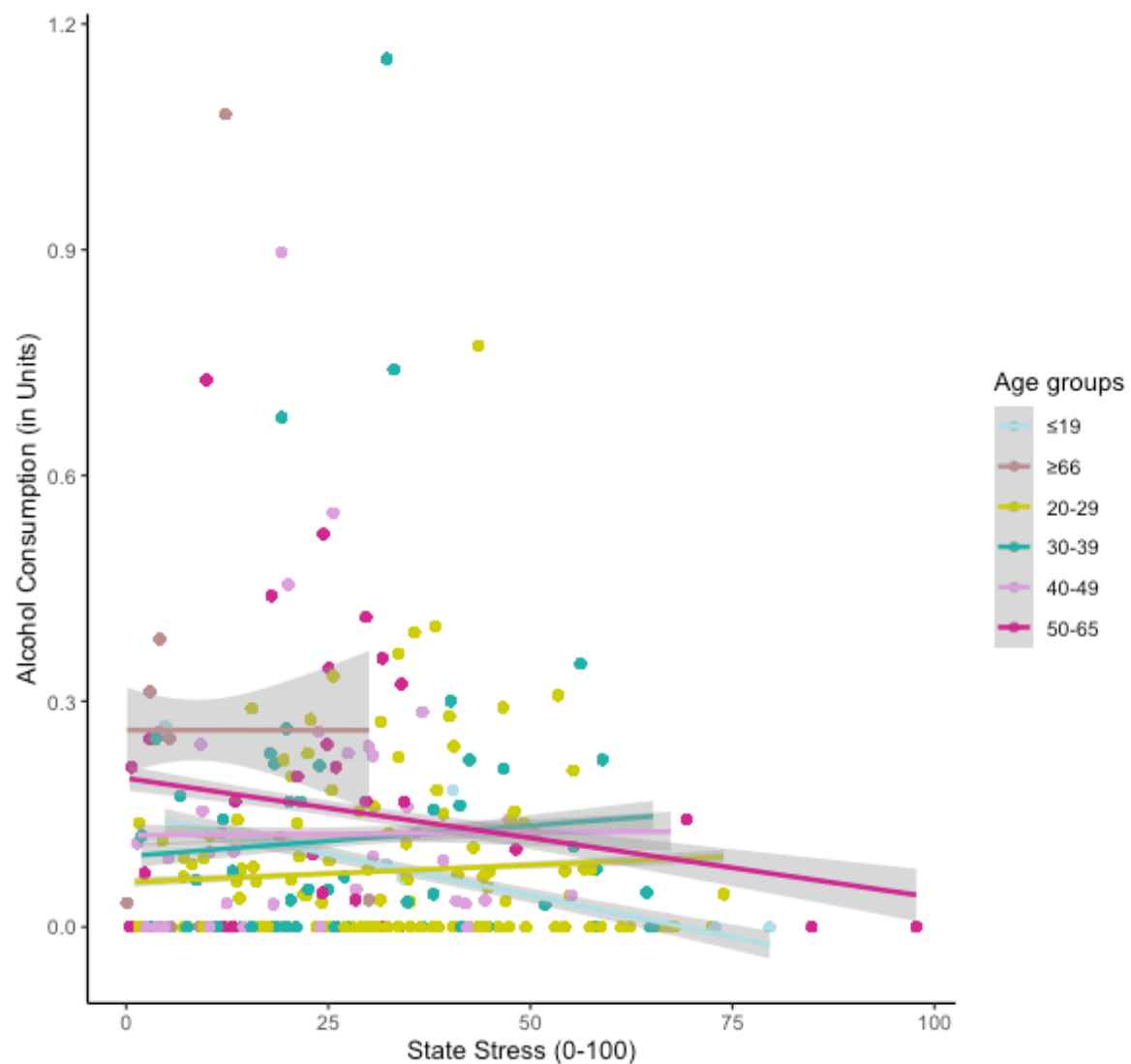


Note. Scatterplot with aggregated state loneliness and alcohol consumption per participant. Each point represents one participant.

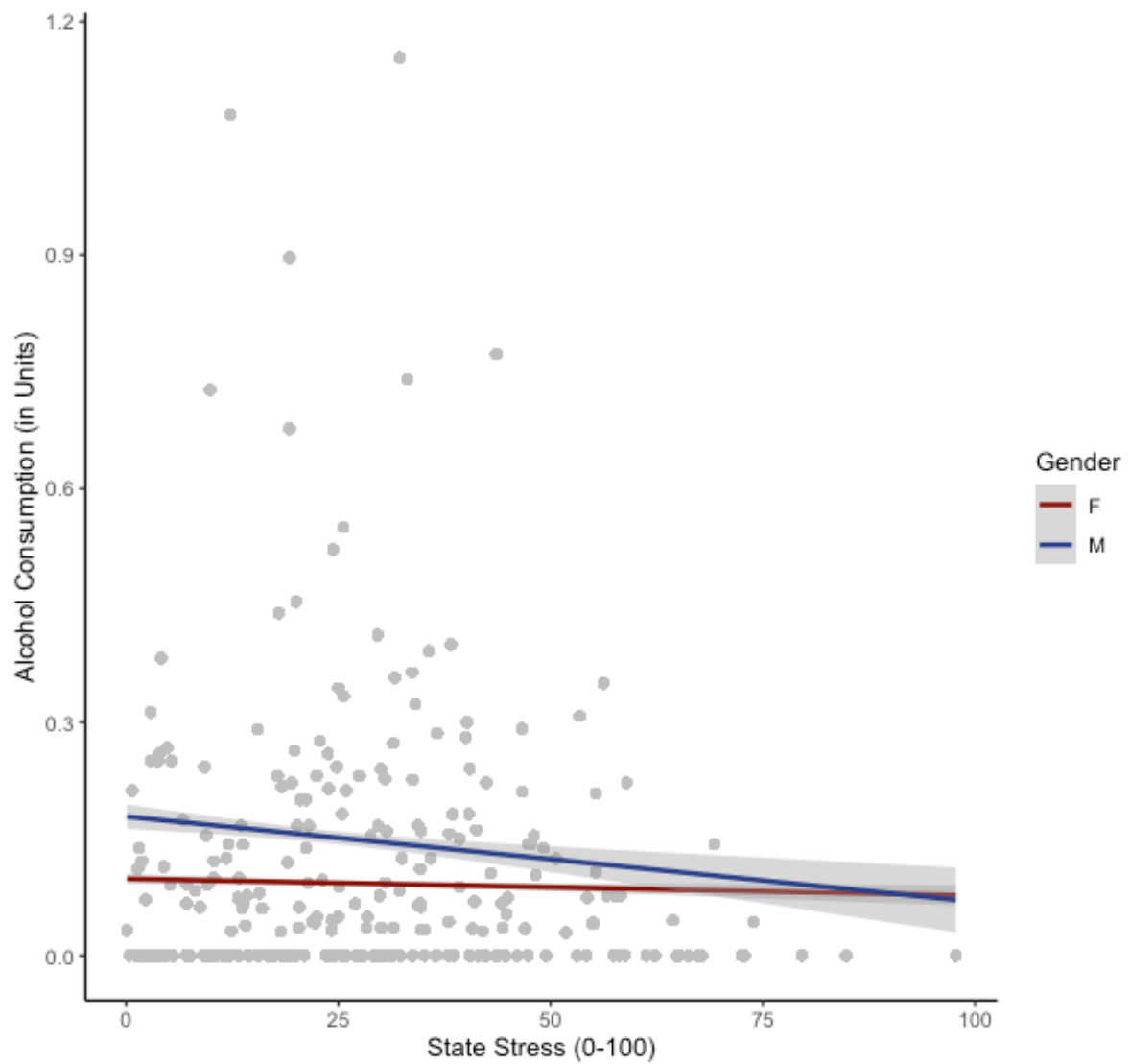
n.s. not significant.

19.2 State Stress

Scatterplot of State Stress and Alcohol Consumption in Different Age-groups



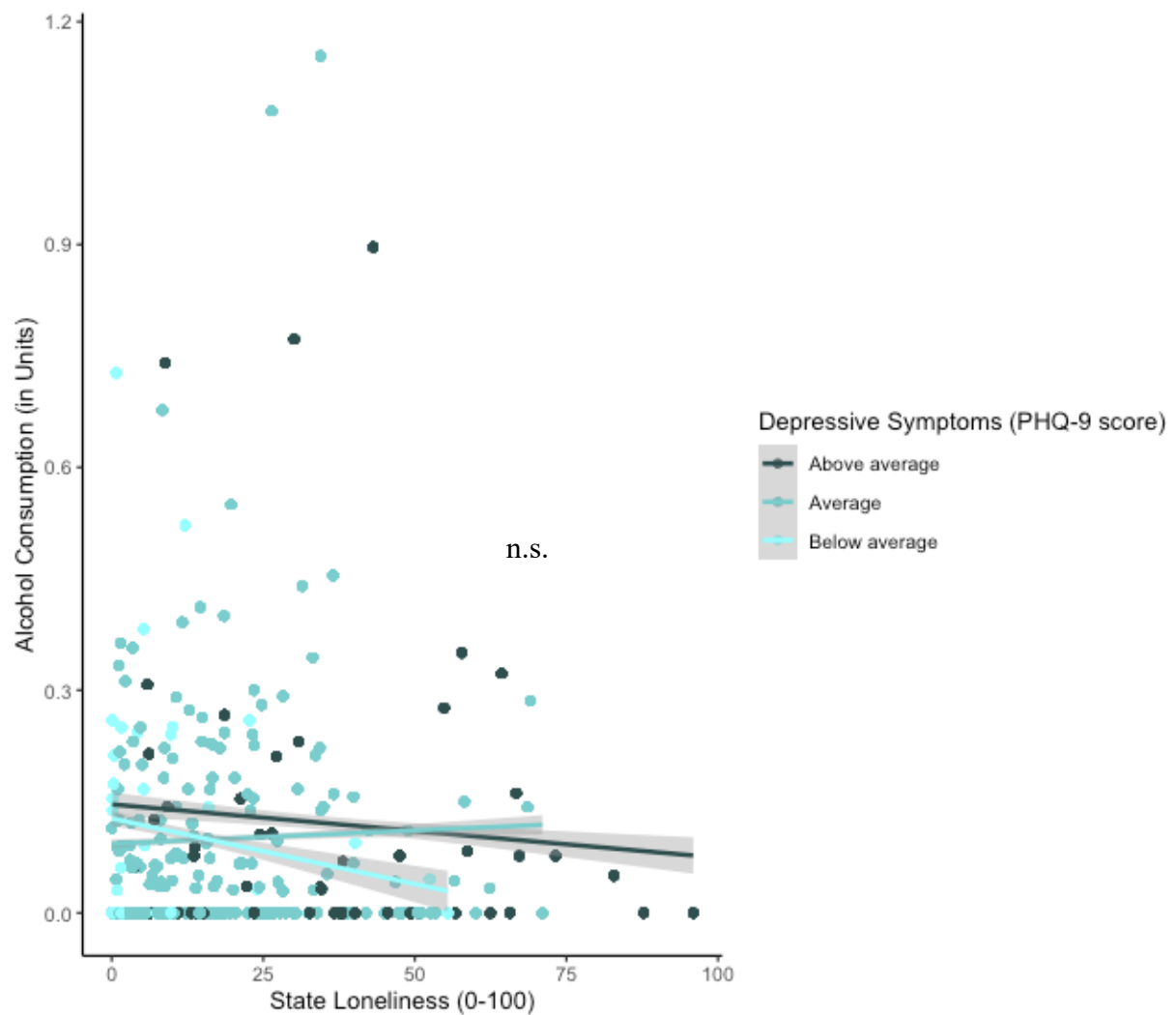
Note. Scatterplot points show entries with aggregated state stress and alcohol units per participant divided by defined age-groups. Each point represents one participant. Not statistically analyzed.

Scatterplot of State Stress and Alcohol Consumption Divided by Gender

Note. Aggregated state stress and alcohol units per participant. Each point represents one participant. Not statistically analyzed.

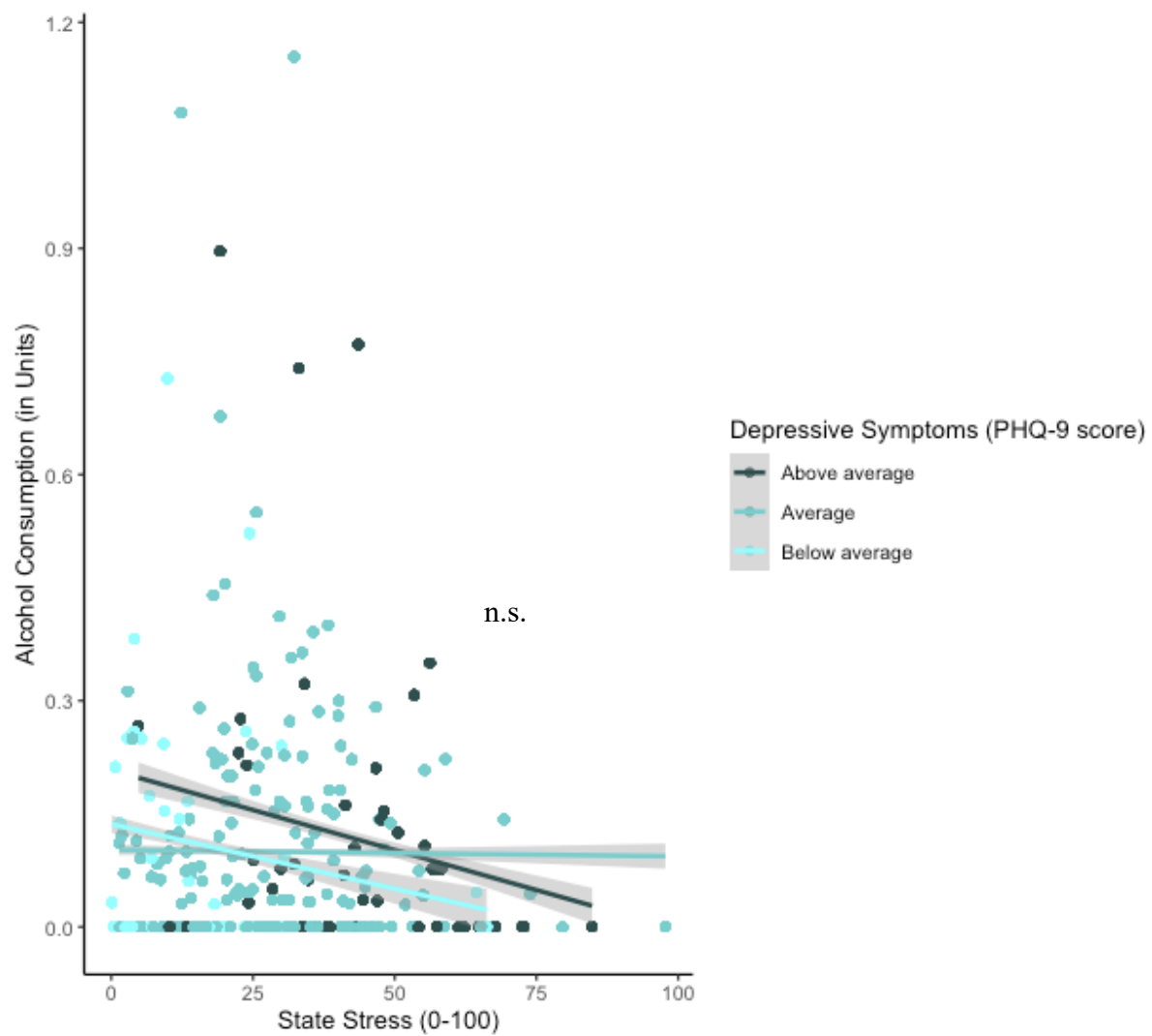
19.3 Depressive Symptoms

State Loneliness, Depressive Symptoms and Alcohol Consumption



Note. State loneliness and alcohol units were aggregated per participant. Each point represents one participant. *Above average:* above 1 SD from mean, *average:* between +1 SD and -1 SD from mean. *below average:* below 1 SD from mean.

n.s. not significant.

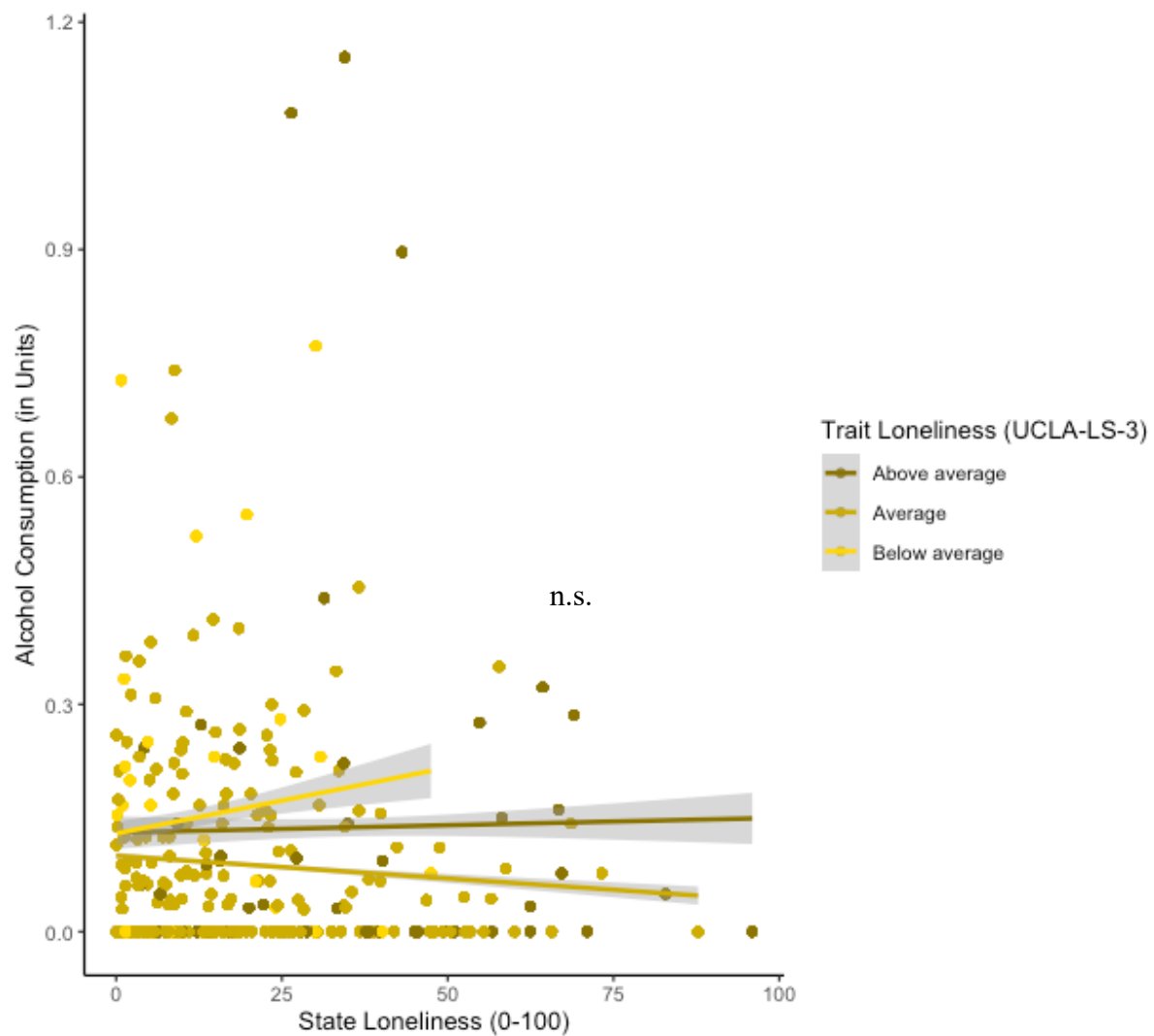
State Stress, Depressive Symptoms and Alcohol Consumption

Note. State Stress and alcohol units were aggregated per participant. Each point represents one participant. *Above average*: above 1 SD from mean, *average*: between +1 SD and -1 SD from mean. *below average*: below 1 SD from mean.

n.s. not significant.

19.4 Trait Loneliness

State Loneliness, Trait Loneliness and Alcohol Consumption

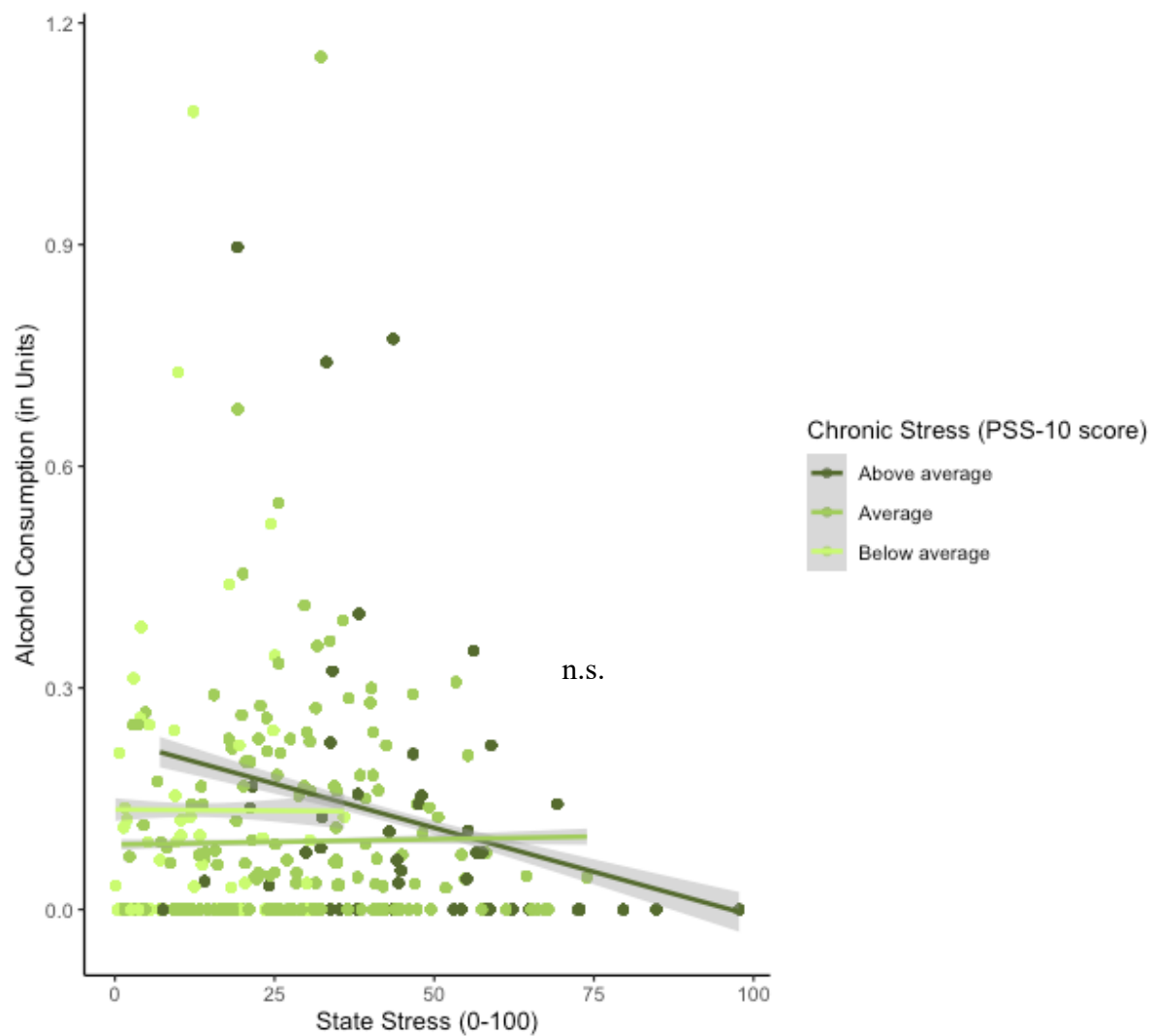


Note. State loneliness and alcohol units were aggregated per participant. Each point represents one participant. *Above average:* above 1 SD from mean, *average:* between +1 SD and -1 SD from mean. *below average:* below 1 SD from mean.

n.s. not significant.

19.5 Chronic Stress

State Stress, Chronic Stress and Alcohol Consumption

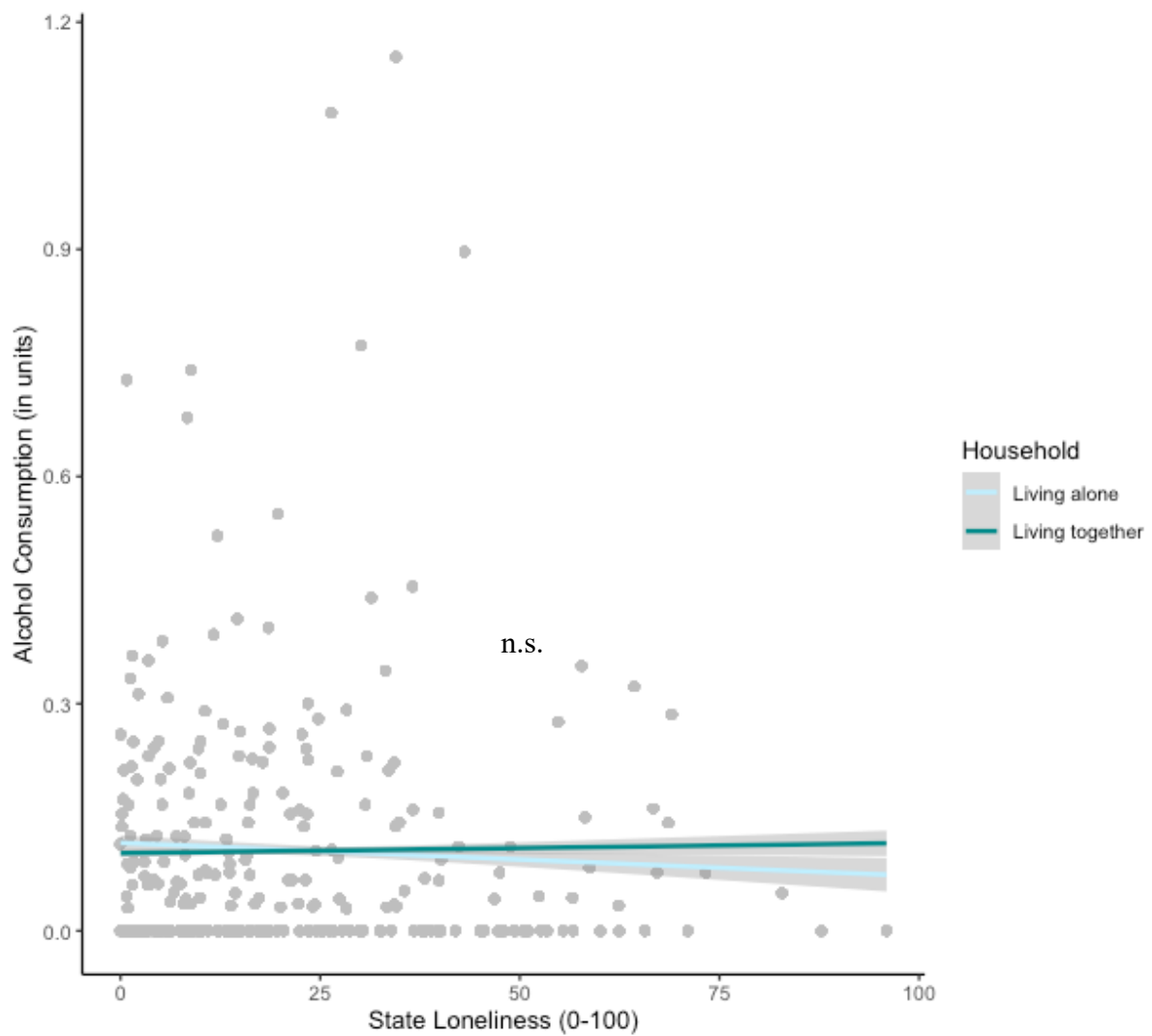


Note. State stress and alcohol units were aggregated per participant. Each point represents one participant. *Above average*: above 1 SD from mean, *average*: between +1 SD and -1 SD from mean. *below average*: below 1 SD from mean.

n.s. not significant.

19.6 Living Alone

State Loneliness, Living Alone and Alcohol Consumption



Note. State loneliness and alcohol units were aggregated per participant. Each point represents one participant.
n.s. not significant.

20 Appendix C. Questionnaires

20.1 UCLA-LS-3

UCLA Loneliness Scale - 3 (UCLA-LS-3) Questionnaire in English

Scale:

INSTRUCTIONS: Indicate how often each of the statements below is descriptive of you.

Statement	Never	Rarely	Sometimes	Often
*1. How often do you feel that you are "in tune" with the people around you?	1	2	3	4
2. How often do you feel that you lack companionship?	1	2	3	4
3. How often do you feel that there is no one you can turn to?	1	2	3	4
4. How often do you feel alone?	1	2	3	4
*5. How often do you feel part of a group of friends?	1	2	3	4
*6. How often do you feel that you have a lot in common with the people around you?	1	2	3	4
7. How often do you feel that you are no longer close to anyone?	1	2	3	4
8. How often do you feel that your interests and ideas are not shared by those around you?	1	2	3	4
*9. How often do you feel outgoing and friendly?	1	2	3	4
*10. How often do you feel close to people?	1	2	3	4
11. How often do you feel left out?	1	2	3	4
12. How often do you feel that your relationships with others are not meaningful?	1	2	3	4
13. How often do you feel that no one really knows you well?	1	2	3	4
14. How often do you feel isolated from others?	1	2	3	4
*15. How often do you feel you can find companionship when you want it?	1	2	3	4
*16. How often do you feel that there are people who really understand you?	1	2	3	4
17. How often do you feel shy?	1	2	3	4
18. How often do you feel that people are around you but not with you?	1	2	3	4
*19. How often do you feel that there are people you can talk to?	1	2	3	4
*20. How often do you feel that there are people you can turn to?	1	2	3	4

Note. Questionnaire is taken from *Journal of Personality Assessment* 66 by Russell (1996), p.20-40.

20.2 PSS-10

Perceived Stress Scale -10 (PSS-10) in English

PERCEIVED STRESS SCALE

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

Name _____ Date _____

Age _____ Gender (Circle): M F Other _____

0 = Never 1 = Almost Never 2 = Sometimes 3 = Fairly Often 4 = Very Often

- | | | | | | |
|--|---|---|---|---|---|
| 1. In the last month, how often have you been upset because of something that happened unexpectedly? | 0 | 1 | 2 | 3 | 4 |
| 2. In the last month, how often have you felt that you were unable to control the important things in your life? | 0 | 1 | 2 | 3 | 4 |
| 3. In the last month, how often have you felt nervous and "stressed"? | 0 | 1 | 2 | 3 | 4 |
| 4. In the last month, how often have you felt confident about your ability to handle your personal problems? | 0 | 1 | 2 | 3 | 4 |
| 5. In the last month, how often have you felt that things were going your way? | 0 | 1 | 2 | 3 | 4 |
| 6. In the last month, how often have you found that you could not cope with all the things that you had to do? | 0 | 1 | 2 | 3 | 4 |
| 7. In the last month, how often have you been able to control irritations in your life? | 0 | 1 | 2 | 3 | 4 |
| 8. In the last month, how often have you felt that you were on top of things? | 0 | 1 | 2 | 3 | 4 |
| 9. In the last month, how often have you been angered because of things that were outside of your control? | 0 | 1 | 2 | 3 | 4 |
| 10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? | 0 | 1 | 2 | 3 | 4 |

Note. Scale is taken from *Journal of Health and Social Behavior*, 23, by Cohen et al. (1983), p. 386-396.

20.3 PHQ-9

Patient Health Questionnaire – 9 (PHQ-9) in English

PATIENT HEALTH QUESTIONNAIRE-9 (PHQ-9)				
Over the <u>last 2 weeks</u> , how often have you been bothered by any of the following problems? (Use "✓" to indicate your answer)	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

FOR OFFICE CODING 0 + + +
=Total Score:

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all	Somewhat difficult	Very difficult	Extremely difficult
☐	☐	☐	☐

Note. Questionnaire is taken from *Journal Gen Intern Med.* 16 (9), by Korenke et al. (2001), p.13.