Self-medication hypothesis:

Influence of mood on substance use during the COVID-19 pandemic

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Abstract

The Covid 19 pandemic had a strong global impact on people's daily lives. In particular, the reduction of social contacts had an influence on people's mood. The self-medication hypothesis postulates that in response to negative mood, people use substances as a means of self-medication (to increase mood). To test the self-medication hypothesis during the Covid-19 pandemic this study analysed correlations between decreases in mood and their effect on substance use in a longitudinal study. The LISS panel, which regularly collects data from 5,000 households in the Netherlands on various topics, was used as the data basis. These data were analysed in terms of general mood and reported amount and frequency of substance use. Subsequently, regression analyses were performed to analyse the predictive power of mood on substance use. A significant negative correlation was found between mood and frequency of substance use (alcohol and illicit drugs) during all timepoints. Furthermore, a significant influence of general mood before the pandemic on substance use could be demonstrated through regression analysis. However, the effects found were very small and other variables such as previous substance use showed a stronger predictive power. Therefore, in this study, the self-medication hypothesis cannot be confirmed for general mood during the Covid-19 pandemic. Implications and limitations of this study are discussed.

Key Words: Covid-19 pandemic, self-medication hypothesis, substance use, mood, LISS panel

Introduction

Mental health is one of the most critical aspects of every individual's life. It is what allows people to lead meaningful and fulfilling lives. Despite this, mental health is often impeded by several live events. This includes anything from significant life changes to traumatic experiences. These events can significantly impact an individual's mental health, often leading to decreased mood or anxiety. In disturbing situations, alcohol or drugs can provide a seeming respite. One of the theories explaining this phenomenon is the self-medication hypothesis. The self-medication hypothesis posits that individuals use drugs and/or alcohol to relieve emotional problems (Khantzian, 1997). The theory has been around for a long time, but there is still much debate about whether it is accurate. However, research suggests that there may be some truth to the self-medication hypothesis (Suh et al., 2008). This paper will explore the self-medication hypothesis by analysing its application during the Covid-19 pandemic, as the pandemic can be considered as a significant life change for many people. Specific, it will explore whether mood had an impact on an individual's substance use based on longitudinal data in the Netherlands.

Covid-19 pandemic impact on mood

To understand the impact of the pandemic on mood it is important to clarify what mood can be considered as. The American Psychiatric Association defines mood as "a disposition to respond emotionally in a particular way[...]" and clarify that "moods differ from emotions in lacking an object; for example, the emotion of anger can be aroused by an insult, but an angry mood may arise when one does not know what one is angry about or what elicited the anger" (American Psychiatric Association, 2022). Depression as most common mood disorder is characterized by feelings of sadness, hopelessness, and worthlessness (American Psychiatric Association, 2013). This study will use a self-rated general mood (the

mean mood over the past 12 months) of the participants, meaning their overall mood of the past year.

Ever since the Covid-19 pandemic broke out, mental health experts have expressed concerns about the potential impact of the pandemic on mental health (World Health Organization, 2022). In specific, the WHO reported significant increases in mental health problems such as mood disorders. For young people an indication of higher risks of suicidal behaviours are reported (World Health Organization, 2022). In addition, studies have revealed that, compared to the same period before the pandemic outbreak, there has been an increase in depressive and other mental health related symptoms (Copeland et al., 2021; Terry et al., 2020).

Several factors are attributed to the increase in depressive symptoms. One reason is that people are struggling with a lot of uncertainty and fear about the future (Satici et al., 2020). When people are constantly worried about their safety and the safety of their loved ones, it can lead to a significant increase in depressive symptoms (Szabó, 2011). Another reason is that social isolation caused by self-isolation or lockdown can lead to loneliness and depressive symptoms (Cacioppo et al., 2011). Worse still, having to deal with all the additional stressors that come with the pandemic (e.g., job loss, financial insecurity) can lead to increased stress levels, and in some cases, to depression.

Several studies have now been published that back up these findings and provide a better comprehension of the impact of the pandemic on mood. A study conducted by Robinson et al. (2022), aimed to systematically review and meta-analyse cohort studies comparing mental health before and after the pandemic. The study found an increase in the number of people seeking treatment for depression. Furthermore, the findings showed that there was a significant increase in mental health problems immediately after the pandemic. Specifically, there was a significant increase in symptoms of mood disorders. The rise in

mental health problems was found to be more pronounced in adults aged 65 years or older and in individuals who reported having a higher number of COVID-19 risk factors. The study provides evidence that the pandemic is related to decreased mood. Anyhow, overall changes were highly variable across the sample and the increased levels in mental health symptoms (e.g., decreased mood) reached pre-pandemic levels (increased) a few months after the pandemic outbreak.

In yet another study by Terry et al. (2020), the authors aimed to investigate the effects of mandatory COVID-19 social distancing restrictions on mood. The study compared mood scores during the period where social distancing restrictions were in place with normative values developed prior to the COVID-19 outbreak. The findings of the study showed that, after the imposition of social distancing restrictions, there was a significant decrease in positive affect leading to significant mood disturbances.

It is also worth noting that the impact of the pandemic on mood may change over time. The early stages of a pandemic are often more stressful than the later stages as suggested by Robinson et al. (2022). As the pandemic progresses, people may become more accustomed to the situation and may not be as affected by it emotionally. Consequently, it is important to monitor mood in the weeks and months after the pandemic has started to better comprehend the long-term effect of the pandemic on mood.

Substance use and abuse (Alcohol and Illicit Drugs)

Substance use describes the usage of substances, while substance abuse refers to the use of drugs or alcohol in a way that is harmful to the individual (Johns Hopkins University, 2022). However, as drugs are nearly always harmful to the individual this differentiation does not seem to provide much insight. To gain a better understanding of substance use in the population it is important to look at past trends and effects of the Covid-19 pandemic on these trends.

According to a 2019 article in the German medical journal "Deutsches Ärzteblatt International," there has been a trend of increasing rates of illegal substance use and in Germany over the past two decades, while legal substance use (alcohol and tobacco) slightly decreased over the same period (Seitz et al., 2019). The authors of the study used data from the Epidemiological Survey of Substance Abuse (ESA) to analyse trends in rates of alcohol abuse, drug abuse, and mental health disorders among adults in Germany between 1995 and 2018 (Seitz et al., 2019). The study found that prevalence of drug abuse has increased since 1995, with substantial increases in rates of cannabis use. The general rising trend of drug use described in Germany could have been further fuelled by the Covid-19 pandemic.

Anyhow, alcohol use might have increased during the Covid-19 pandemic. First reports of the OECD show that based on government tax data alcohol sales increased by 3 – 5 % in Germany, the United Kingdom and the United States from 2019 to 2020 showing that possibly the Covid-19 pandemic had an impact on alcohol use in these countries (OECD, 2021). More information about changes due to the Covid-19 pandemic provides the National Drug Monitor (NDM) with an up-to-date picture of drug, alcohol and tobacco use in the Netherlands (Nationale Drug Monitor, 2021). According to the NDM several studies suggest an increase of cannabis users that use more cannabis compared to users who have started to use less due to the covid-19 pandemic, especially heavy users have increased their consumption whereas occasional users often stopped consuming. Studies of alcohol use, sleeping pills or tranquilizers, and cocaine show a mixed picture - some people have started drinking less since the Covid 19 pandemic, while others have started drinking more. For party drugs such as ecstasy, amphetamines generally, nitrous oxide and GHB (gamma-hydroxybutyric acid) use has decreased since the covid-19 pandemic. This seems to be related to the closed night venues. Only the usage of ketamine was described as steady. For opioids no data was found.

Overall, it can be said that studies indicate different trends regarding substance use. To further understand why people use substances, the self-medication hypothesis is one of the most common theories.

Self-medication hypothesis

Substance use and mood are two critical issues that often intersect. Substance use can lead to decreased mood and vice versa. It is important to understand the relationship between these two issues to further understand how substance use can be seen as a self-medication for decreased mood as proposed by the self-medication hypothesis.

An epidemiological study on the prevalence of psychiatric and substance use disorders of a national sample in the United States showed that mood disorders (especially decreased mood) increase the risk of substance use disorders (harmful substance abuse) (Kessler et al., 1994). A systematic review and meta-analysis from 1990 until 2014 by Lai et al. (2015) confirmed this association. Illicit drug and alcohol use disorders were highly associated with major depression and any anxiety disorder (Lai et al., 2015).

According to the National Institute on Drug Abuse, substance abuse and mental health disorders are "co-occurring conditions" (National Institute on Drug Abuse, 2020). Several risk factors for both addiction and mental health disorders include stress, family history, early exposure to drugs or alcohol, traumatic experiences, and social isolation (National Institute on Drug Abuse, 2020). As risk factors are similar for both conditions their co-occurrence might be explainable.

The self-medication hypothesis is a model that posits a link between mood and substance use. According to this hypothesis, people with subjective states of distress and suffering (e.g. decreased mood) may turn to substances to self-medicate their symptoms (Khantzian, 1997). While there is substantial evidence supporting the self-medication hypothesis, researchers still argue about its validity.

In a review of the self-medication hypothesis, Khantzian (1997) presents evidence supporting the model from both clinical and research studies. He argues that the self-medication hypothesis can account for a wide range of behaviours related to substance use and mood disturbances. For example, the self-medication hypothesis can help to explain why people with mood disturbances may abuse drugs or alcohol, why they may seek out multiple drugs, and why they may continue to use substances even when doing so is harmful. According to Khantzian, there exist two significant elements of the Self-medication hypothesis. The first element is that usage of substances helps to relieve psychological distress, and the second is that the preference of the substances is shaped by the individual's psychological makeup. Thus, many patients even experiment with different drugs to find the one that gives them the most relief.

To better understand how the SMH applies to substance use disorders, Suh et al., (2008) conducted a qualitative analysis of interviews with people who had experience with both mood disorders and substance use disorders. This study suggests that there are several ways in which people with mood disturbances may use substances to self-medicate. Some people may use substances to relieve negative emotions, while others may use them to boost positive emotions. Additionally, some people may use substances to avoid difficult emotional experiences, while others may use them to cope with stress.

Turner et al., (2018) also explore how the model may apply to mood and anxiety disorders. The authors examined the link between anxiety and mood disorders on the one hand and alcohol or drug use on the other hand. The findings of this review suggest that there is a significant link between these two conditions, showing that about one in four people (21.9 % - 24.1 %) self-medicate with drugs and alcohol when suffering from mood and anxiety disorders. Individuals with mood and anxiety disorders have higher rates of using

alcohol or drugs, and they are also more likely to experience adverse outcomes due to their substance use.

The findings indicate that the self-medication hypothesis is relevant for both mood and substance use disorders. However, while the self-medication hypothesis is useful in explaining a wide range of behaviours related to disorders, further studies are required to understand their application to a population sample. This research will help clarify the role of self-medication during the Covid-19 pandemic and its application to a population sample.

Aim of this study

Overall, the Covid-19 pandemic has and had an impact on substance use and mood as shown previously. The pandemic has caused a great deal of stress for many people. Therefore, individuals may have self-medicated with substances to cope. To test the self-medication hypothesis during the Covid-19 pandemic this study analyses correlations between decreases in mood and their effect on substance use in a longitudinal study of 5.000 households with the following research hypotheses:

Research hypothesis 1

There is a decrease in general mood for the Dutch population during the Covid-19 pandemic (2020 and 2021) compared to before the Covid-19 pandemic (2018 and 2019).

Research hypothesis 2

There is an increase in substance use for Dutch population during the Covid-19 pandemic (2020 and 2021) compared to before the Covid-19 pandemic (2018 and 2019).

Research hypothesis 3

There is a negative relation between general mood and substance use during all timepoints (2018, 2019, 2020, 2021).

Research hypothesis 4

The mean general mood before the pandemic (2018, 2019) and the change in mood during the pandemic (difference between 2018, 2019 and 2020, 2021) can predict substance use during the pandemic (2020, 2021).

Methods

Design

The study is based on data provided by the LISS panel ((Longitudinal Internet studies for the Social Sciences) (Centerdata, 2022). The sample size of the panel consists of 5.000 households (approximately 7.500 participants). Recruitment was carried out in 2007 using a random sample of 10,150 addresses drawn from the population register by Statistics Netherlands. In 2009, a stratified refresher sample was recruited through which the representativeness of the panel was improved by overrepresenting several previously underrepresented groups. Panel members complete online questionnaires each month and are paid to participate. A member of the household provides the household data and updates this information periodically.

A correlational study (quantitative) was conducted, using the data of the LISS panel (Centerdata, 2022). The study used a within-subjects design. For this study the modules health (2) and personality (7) of the LISS panel were used (Centerdata, 2022). Independent variable was the self-reported mood before (data collection period: 05.2018-07.2018 & 05.2019-07.2019) and during (data collection period: 05.2020-07.2020 & 05.2021-07.2021) the Covid-19 pandemic. Dependent (and partly independent) variable was the self-reported substance usage before (data collection period: 11.2018-01.2019 & 11.2019-01.2020) and during (data collection period: 11.2020-01.2021 & 11.2021-01.2022) the Covid-19 pandemic. The Covid-19 pandemic was considered as timeframe from March 2020 until today (2022) the timeframe from 2018 until March 2020 was used as comparison (before pandemic).

Participants

Participants in this sample included 9792 people. Participants who did not answer all questionnaires at all four timepoints were excluded from the sample (*n* = 6490; 66%). The final analysis was conducted with 3302 subjects (1708 female, 1591 male, 3 no answer). Most of the participants were married (*n* = 1918; 58,1%) or never been married (*n* = 754; 22,9%), some were divorced (*n* = 369; 11,2%), widow or widower (*n* = 246; 7,5%) or separated (*n* = 12; 0,4%); 3 participants did not answer. Participants place of residence was not urban (*n* = 786; 24%), very urban (*n* = 709; 21,6%), slightly urban (*n* = 652; 19,9%), moderately urban (*n* = 617; 18,8%) or extremely urban (*n* = 516; 15,7%); 3 participants did not answer. Most participants had a Dutch background (*n* = 2701; 84%), some participants had a first-generation foreign background (*n* = 258; 8,1%) or a second-generation foreign background (*n* = 256; 8%); 87 participants did not answer. Most participants held an HBO degree (higher vocational education) (*n* = 873; 26,5%), an MBO degree (intermediate vocational education) (*n* = 807; 24,5%) or an VMBO degree (intermediate secondary education) (*n* = 701; 21,3%), some participants had a WO degree (university degree) (*n* = 408; 12,4%), a HAVO/VWO degree (higher secondary education/senior high school) (*n* = 318; 9,7%) or primary school degree (*n* = 183; 5,6%); 11 participants did not answer. The mean subject age was 58.58 (*SD* = 16.63; range: 19-104).

The excluded participants and the used sample showed no evidence of significant differences for gender (χ^2 (1) = 1.050, p = .305, φ = 0.010). Significant differences between the two samples (excluded and used) were found for civil status ($\chi^2(4)$ = 1020.563, p < .001, φ = 0.323), urban character of place of residence ($\chi^2(4)$ = 13.528, p = .009, φ = 0.037), origin ($\chi^2(4)$ = 74.129, p < .001, φ = 0.103), level of education ($\chi^2(5)$ = 441.296, p < .001, φ = 0.219), and age ($t(9787)$ = 49.036, p < .001, d = 1.049) (Table A1). The people in the used

sample showed a higher level of education, less migration background, less people living in an extremely urban place, more married people, and an overall older age.

Material

Mood questions

Mood was assessed through two questions as state (current mood) and trait (general mood). Participants rated their subjective feeling on a seven-point Likert scale ranging from very bad (one) to very good (seven). This study only focussed on trait mood (in the following described as general mood).

For reliability analysis, test-retest was calculated using intercorrelations to assess the internal consistency of the subscale for general mood. The Test-retest reliability was satisfying (*correlation coefficients* > .58). Even though a single item was used to assess mood, studies show that single items can provide good psychometric properties when used in large-scale panel studies (like this study) (Diener et al., 2018).

Substance use questions

Alcohol use was assessed through one question about the participants alcohol consumption over the last 12 months. Participants rated the frequency on an eight-point Likert scale ranging from almost every day (one) over once or twice a month (five) to not at all (eight). If participants drank alcohol during the past 12 months a follow-up question regarding their consumption in the past seven days was asked and detailed questions about an example day with the highest amount of consumption in the past seven days. For data analysis the amount of alcohol was calculated in gram pure alcohol for this example day.

The Test-retest reliability was satisfying, with all intercorrelation coefficients being above .80 for frequency of alcohol consumption and above .58 for amount of alcohol consumption.

Illicit drug use was assessed using one question about the use of five different substance groups (namely: sedatives, soft drugs (e.g., marijuana), XTC, hallucinogens, hard drugs (e.g., heroin, cocaine), laughing gas) over the past month. Participants were asked to rate their consumption on a three-point Likert scale ranging from never (one) to regularly (three). For the analysis a mean of these values was used.

The Test-retest reliability was satisfying, all intercorrelation coefficients being above .56 for frequency of illicit drug use.

Data analysis

Data analysis was processed using Version 27 of IBM SPSS Statistics for Windows (IBM Corp., 2022).

First, assumptions for all statistical analyses to perform were checked.

Then, to investigate hypotheses one and two, changes from before the pandemic (2018 until 2020) to during the pandemic (2020 until 2022) for mood and substance use were investigated using repeated measures ANOVAs.

It was planned to investigate the correlation between mood and substance use during all timepoints (2018, 2019, 2020, 2021) as proposed by hypothesis three using Pearson product moment correlation.

Afterwards multiple linear regression was used to determine whether general mood before the pandemic and it's change to during the pandemic can be seen as predictors of substance use during the pandemic as proposed by hypothesis four. To predict substance use, calculations were made separately for illicit drugs and alcohol.

Frequency of alcohol consumption and illicit drug use in 2020 was predicted from the mean of the self-reported general mood of the years 2018 and 2019 and the change of this mean general mood compared to 2020. Frequency of alcohol consumption and illicit drug use in 2021 was predicted from the mean of the self-reported general mood of the years 2018 and

2019 and the change of this mean general mood compared to the mean of the general mood of 2020 and 2021.

In addition, a second analysis was run using the same variables but including the mean of the substance use of 2018 and 2019 as predictor variables to compare effects.

Civil status, urban character of place of residence, origin, level of education, and age differed significantly between the excluded part of the sample and the used sample (Table A1). To control for potential cofounding of the regression analysis it was decided to include above mentioned demographics in a third analysis to check whether these might have influenced the results.

Assumption testing repeated measures ANOVAs

The conditions (Dependence of measurements, dependent variables at least interval scaled, within-subject factor nominally scaled) for performing repeated measures ANOVAs were met for all variables. The Greenhouse–Geisser adjustment was used to correct for violations of sphericity.

Normal distribution

For all repeated measures ANOVAs variables were not normally distributed, as assessed by the Shapiro-Wilk test ($p < .001$). As the sample size was large ($n > 30$) analytical tests become more sensitive to only minimal deviations from the normal distribution (Field, 2018). Therefore, it was decided to check the Q-Q plot distribution, which did not deviate strongly from normal distribution. In addition, research has shown that repeated measures ANOVA is robust against violations of normal distribution (Wilcox, 2012). Thus, it was decided to continue the analysis.

Outliers

For general mood, 19 mild outliners (1.5 times the interquartile range) and 10 extreme outliners (3 times the interquartile range) were found in the data.

No outliners were found in the data for frequency of alcohol consumption.

For amount of alcohol consumption, 141 outliners were found for 2018, 146 outliers for 2019, 121 outliers for 2020, and 95 outliers for 2021 in the data (all at least 1.5 times above the interquartile range).

For frequency of illicit drug use 16 outliners were found for 2018, 18 outliers for 2019, 16 outliers for 2020, and 15 outliers for 2021 in the data (all at least 1.5 times above the interquartile range).

All outliers found were not excluded as they showed overall consistent responsiveness.

Assumption testing Pearson product moment correlations

The conditions for performing Pearson product moment correlation were not fully met for all variables. Outliers were previously checked for all variables. A clear linearity could not be proven; however no non-linear correlation was evident either, when checked through scatterplots. All variables were not normally distributed, as assessed by the Shapiro-Wilk test ($p < .001$). As discussed previously, analytical tests become more sensitive to only minimal deviations from the normal distribution if the sample size large ($n > 30$) (Field, 2018). Thus, to check whether the possible violation of normality had an influence on the results, correlations using Spearman rank were calculated additionally.

Assumption testing multiple linear regressions

The conditions for performing multiple linear regression were met for both models. A linearity between unstandardized predicted values and studentized residuals through scatterplots could be proven. No outliers were found through case wise diagnostics, studentised excluded residuals, leverage, or cooks' distance for both frequency of alcohol consumption models (2020 & 2021). Sixty-five outliers were found for the 2020 illicit drug frequency model and 69 for the 2021 illicit drug frequency model but kept in the data, as they

showed overall consistent responsiveness. The models had no autocorrelation as the values of the Durbin-Watson statistic were 2.014 and 2.039 (frequency of alcohol use), and 2.037 and 2.003 (frequency of illicit drug use). No multicollinearity or heteroscedasticity was found for all models. Residuals were normally distributed for frequency of alcohol consumption but not normally distributed for frequency of illicit drug use, which was expected due to the small amount of drug users in the sample. Anyhow, it was decided to continue the analysis as research suggests that a violation of the normality assumption for linear regression not noticeably impacts results (Schmidt & Finan, 2018).

Results

Changes in general mood from pre- to during pandemic

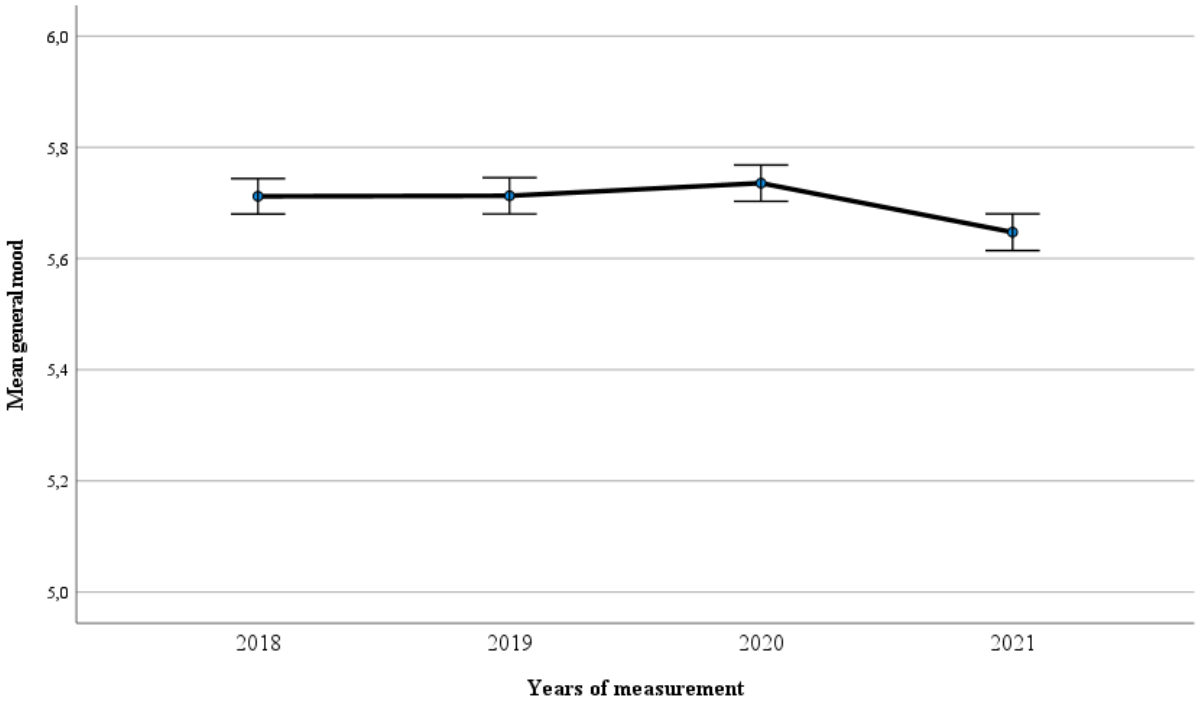
The repeated measures ANOVA with a Greenhouse-Geisser correction determined that mean general mood showed a statistically significant difference between measurement points, F (2.98, 9820.26) = 4.80, $p < .001$, partial $\eta^2 = .004$. The eta-squared indicates a very small effect, as suggested by Cohen (Cohen, 2013).

General mood was highest in 2020 (M = 5.74, SD = 0.95), lower in 2018 (M = 5.71, SD = 0.93), and 2019 (M = 5.71, SD = 0.96) and lowest in 2021 (M = 5.65, SD = 0.97) (Figure 1). Overall, the mean general mood was found to be above average of the response scale (>5) on all four timepoints (scale: 1-7).

Bonferroni-adjusted post-hoc analysis revealed significantly ($p < .05$) lower general mood in 2021 compared to all other timepoints (2018 (*MDiff* = -0.065, 95%-CI [-0.10, -0.03]), 2019 (*MDiff* = -0.065, 95%-CI [-0.10, -0.03]), 2020 (*MDiff* = -0.088, 95%-CI [-0.13, -0.05])). All other differences were not statistically significant. Thus, a small decrease in general mood was found in 2021 for the Dutch population compared to before the Covid-19 pandemic and compared to the beginning of the pandemic (2020) (Figure 1). Therefore, hypothesis one can be partly confirmed.

Figure 1

Differences on rated general mood between timepoints.



Notes: Error bars indicate the 95% confidence interval.

Changes in frequency of alcohol consumption from pre- to during pandemic

The repeated measures ANOVA with a Greenhouse-Geisser correction determined that mean alcohol consumption showed a statistically significant difference between measurement points, F (2.72, 8972.49) = 35.01, $p < .001$, partial $\eta^2 = .011$.

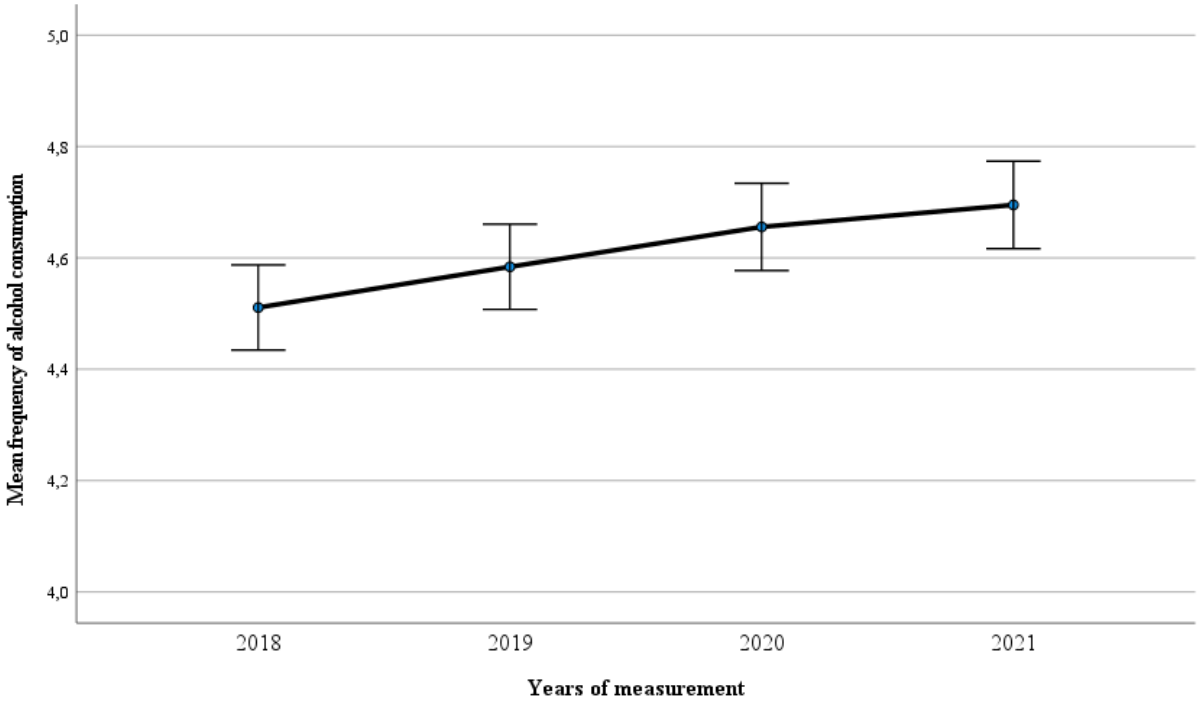
Frequency of alcohol consumption was lowest in 2018 (M = 4.51, SD = 2.24) and increased every year (2019 (M =4.58, SD = 2.24), 2020 (M = 4.66, SD = 2.30)) until it reached its high in 2021 (M = 4.70, SD = 2.30). Overall, the mean frequency of alcohol consumption was on all timepoints about once or twice a month (Scale 1-8).

Bonferroni-adjusted post-hoc analysis revealed significantly ($p < .001$) higher frequency of alcohol consumption in 2020 compared to 2018 (*MDiff* = 0.15, 95%-CI [0.09, 0.19]) and 2019 (*MDiff* = 0.07, 95%-CI [0.02, 0.12]) and 2021 compared with 2018 (*MDiff* = 0.18, 95%-CI [0.23, 0.24]) and 2019 (*MDiff* = 0.11, 95%-CI [0.06, 0.17]). Frequency of

alcohol consumption increased for the Dutch population during the Covid-19 pandemic (2020 and 2021) compared to before the Covid-19 pandemic (2018 and 2019) (Figure 2). Therefore, hypothesis two can be confirmed for alcohol use frequency, even though the found effects were small.

Figure 2

Differences on rated mean alcohol frequency between timepoints.



Notes: Error bars indicate the 95% confidence interval.

Changes in amount of alcohol consumption from pre- to during pandemic

The repeated measures ANOVA with a Greenhouse-Geisser correction determined that mean alcohol consumption showed a statistically significant difference between measurement points, F (2.97, 3715.18) = 4.12, p = .006, partial η^2 = .003.

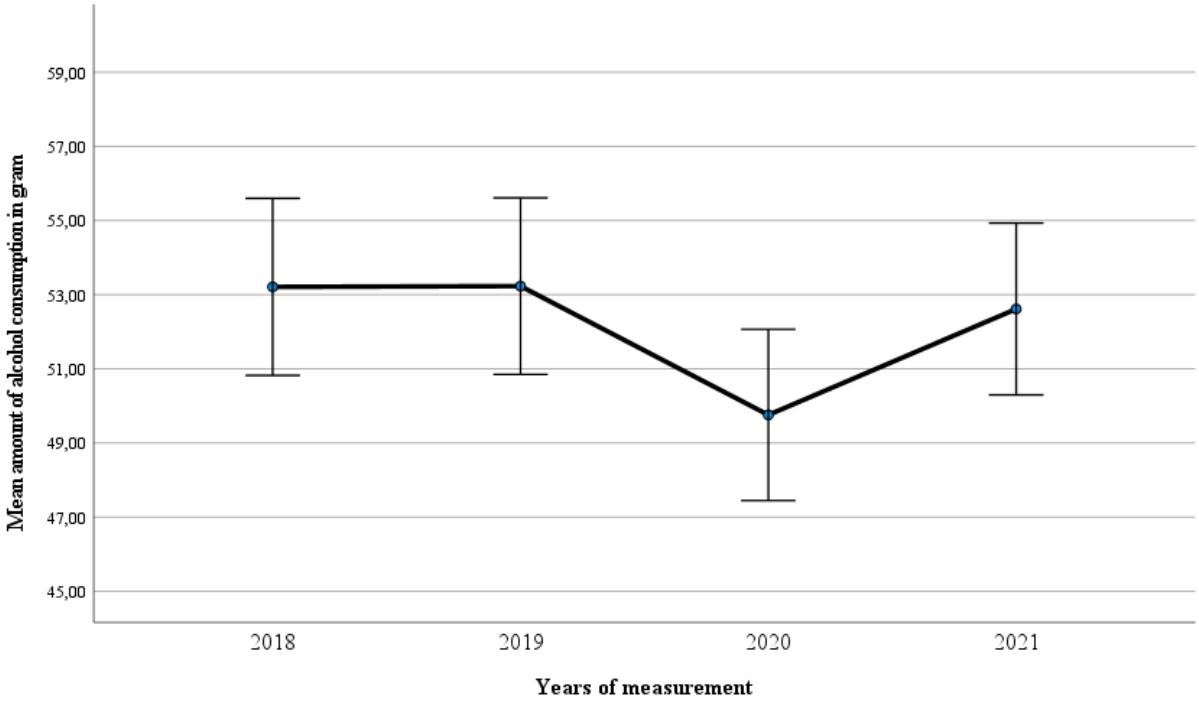
Amount of alcohol consumption was the highest in 2018 (M = 53.221, SD = 43.12) and 2019 (M = 53.23, SD = 42.99), decreased in 2020 (M = 49.76, SD = 41.68) and increased again in 2021 (M = 52.62, SD = 41.81). Overall, the mean amount of alcohol consumption

was comparably high (about five standard amounts), as the day with the highest consumption in the week was used. Nevertheless, a huge variance across the Dutch population was found.

Bonferroni-adjusted post-hoc analysis revealed significantly ($p < .05$) higher alcohol consumption in 2018 compared to 2020 (*MDiff* = 3.45, 95%-CI [0.34, 6.57]) and 2019 compared with 2020 (*MDiff* = 3.47, 95%-CI [0.29, 6.66]) (Figure 3). All other differences were not statistically significant. The amount of alcohol consumption did not increase for the Dutch population during the Covid-19 pandemic (2020 and 2021) compared to before the Covid-19 pandemic (2018 and 2019) but decreased in 2020. Therefore, hypothesis two cannot be confirmed for amount of alcohol consumption.

Figure 3

Differences on rated mean alcohol consumption in gram between timepoints.



Notes: Error bars indicate the 95% confidence interval.

Changes in frequency of illicit drug consumption from pre- to during pandemic

The repeated measures ANOVA with a Greenhouse-Geisser correction determined that frequency of illicit drug consumption showed no statistically significant difference between measurement points, F (2.91, 9579.74) = 2.29, p = .08, partial η^2 = .001.

Bonferroni-adjusted post-hoc analysis revealed no significant differences between measurement points. Illicit drug consumption was stable across all four years. Therefore, hypothesis two cannot be confirmed for frequency of illicit drug consumption.

Correlations between general mood and substance use

General mood and frequency of alcohol consumption correlated negatively significant, but small at all timepoints (Table 1).

Table 1

Correlations between frequency of alcohol consumption and general mood at measurement timepoints.

		Mood 2018	Mood 2019	Mood 2020	Mood 2021
Freq. alcohol 2018	Correlation coefficient	-.116***			
Freq. alcohol 2019	Correlation coefficient	-.103***	-.123***		
Freq. alcohol 2020	Correlation coefficient	-.098***	-.107***	-.103***	
Freq. alcohol 2021	Correlation coefficient	-.105***	-.102***	-.104***	-.115***

Notes: Correlation was calculated using Pearson product moment correlation. *Sig.* = Significance. *Freq.* = Frequency * $p < .05$ ** $p < .01$ *** $p < .001$

General mood and amount of alcohol consumption only correlated significantly in 2020 and the general mood in 2019 correlated significantly with amount of alcohol consumption in 2021, both correlations found were very small (Table A2). All other correlations were not significant.

For general mood and frequency of illicit drug consumption significant, but small correlations were found at all timepoints (Table 2).

Table 2

Correlations between frequency of illicit drug consumption and general mood at measurement timepoints.

		Mood 2018	Mood 2019	Mood 2020	Mood 2021
Freq. drugs 2018	Correlation coefficient	-.147***			
Freq. drugs 2019	Correlation coefficient	-.179***	-.171***		
Freq. drugs 2020	Correlation coefficient	-.144***	-.158***	-.164***	
Freq. drugs 2021	Correlation coefficient	-.141***	-.148***	-.130***	-.137***

Notes: Correlation was calculated using Pearson product moment correlation. *Sig.* = Significance. *Freq.* = Frequency * $p < .05$ ** $p < .01$ *** $p < .001$

To check for influences of the violation of normality all correlations were additionally calculated using Spearman rank correlation. The found pattern was similar for frequency of alcohol consumption and frequency of drug use. For amount of alcohol consumption more correlations were found. As these correlations were very small it was decided to not additionally report the results.

Conclusion

There was a negative correlation between frequency of alcohol consumption and illicit drug use with general mood on all timepoints. Anyhow, amount of alcohol consumption did not correlate significantly with general mood on all timepoints. Therefore, hypothesis three can be confirmed for frequency of alcohol and illicit drug use, but not confirmed for amount of alcohol consumption. All found correlations were small.

Regression analysis for general mood and alcohol consumption

As amount of alcohol consumption has not been correlative at all timepoints with general mood no regression analysis will be pursued for these variables.

Predicting alcohol use frequency

The R^2 for the overall 2020 model was .013 (adjusted R^2 = .012) and for the 2021 model .015 (adjusted R^2 = .014), both indicative for a small overall explained variance (Cohen, 2013). The models (2020 and 2021) were able to statistically significant predict frequency of alcohol consumption in 2020 (F (2, 3297) = 21.196, p < .001) and 2021 (F (2, 3293) = 25.145, p < .001). Anyhow, only in the 2021 model both coefficients were able to statistically significant predict alcohol use frequency (Table 3).

Table 3

Regression coefficients for alcohol use frequency

Model	Coefficients	Beta
2020	Mean mood pre-pandemic	-0.112***
	Change in mood	0.006
2021	Mean mood pre-pandemic	-0.124***
	Change in mood	0.040

Notes: *Beta.* = Standardized regression coefficient. * p < .05 ** p < .01 *** p < .001.

Controlling for pre-pandemic alcohol consumption

The R^2 for the overall 2020 model was .814 (adjusted R^2 = .814) and for the 2021 model .773 (adjusted R^2 = .773), both indicative for a large overall explained variance (Cohen, 2013). When adding mean alcohol consumption frequency of 2018 and 2019 to the model it was still able to statistically significant predict frequency of alcohol consumption in 2020 (F (3, 3292) = 4704.772, p < .001) and 2021 (F (3, 3288) = 3741.675, p < .001).

In both models the variables general mood before the pandemic and change of general mood became non-significant when adding pre-pandemic alcohol consumption frequency (Table 4).

Table 4

Regression coefficients for alcohol use frequency controlling for pre-pandemic alcohol use

Model	Coefficients	Beta
2020	Mean mood pre-pandemic	0.008
	Change in mood	0.001
	Mean alcohol use pre-pandemic	0.902***
2021	Mean mood pre-pandemic	-0.003
	Change in mood	-0.013
	Mean alcohol use pre-pandemic	0.879***

Notes: *Beta.* = Standardized regression coefficient. * $p < .05$ ** $p < .01$ *** $p < .001$.

Controlling for cofounders

The R^2 for the overall 2020 model was .078 (adjusted $R^2 = .076$) and for the 2021 model .072 (adjusted $R^2 = .070$), both indicative for a small overall explained variance (Cohen, 2013). The models (2020 and 2021) were able to statistically significant predict frequency of alcohol consumption in 2020 (F (7, 3179) = 38.280, $p < .001$) and 2021 (F (7, 3175) = 35.086, $p < .001$).

After including the demographic variables both models still showed a small goodness-of-fit, but it increased compared to the model without the demographic variables. In addition, some cofounding variables were significant and for the 2021 model the variable change in mood became non-significant (Table 5). Therefore, cofounding might have occurred for this variable.

Table 5

Regression coefficients for alcohol use frequency controlling for cofounders

Model	Coefficients	Beta
2020	Mean mood pre-pandemic	-0.058**
	Change in mood	-0.002
	Civil status	-0.017
	Place of residence	-0.021
	Origin	0.067***
	Level of education	-0.159***
	Age	-0.234***
2021	Mean mood pre-pandemic	-0.074***
	Change in mood	0.031
	Civil status	-0.011
	Place of residence	-0.024
	Origin	0.069***
	Level of education	-0.161***
	Age	-0.204***

Notes: *Beta.* = Standardized regression coefficient. * $p < .05$ ** $p < .01$ *** $p < .001$.

Regression analysis for general mood and illicit drug use

The R^2 for the overall 2020 model was .030 (adjusted $R^2 = .029$) and for the 2021 model .023 (adjusted $R^2 = .023$), both indicative for a small overall explained variance (Cohen, 2013). The models (2020 and 2021) were able to statistically significant predict frequency of illicit drug use in 2020 (F (2, 3297) = 50.356, $p < .001$) and 2021 (F (2, 3293) = 39.514, $p < .001$). Anyhow, looking at the coefficients only general mood before the pandemic was able to statistically significant predict illicit drug use frequency (Table 6).

Table 6

Regression coefficients for illicit drug use frequency

Model	Coefficients	Beta
2020	Mean mood pre-pandemic	-0.170***
	Change in mood	0.020
2021	Mean mood pre-pandemic	-0.156***
	Change in mood	0.031

Notes: *Beta.* = Standardized regression coefficient. * $p < .05$ ** $p < .01$ *** $p < .001$.

Controlling for pre-pandemic illicit drug use

The R^2 for the overall 2020 model was .469 (adjusted R^2 = .468) and for the 2021 model .334 (adjusted R^2 = .333), both indicative for an average overall explained variance (Cohen, 2013). When adding mean illicit drug use frequency of 2018 and 2019 to the model it was still able to statistically significant predict frequency of illicit drug use in 2020 (F (3, 3291) = 968.185, p = .003) and 2021 (F (3, 3287) = 548.505, p < .001).

Different to the alcohol frequency models, the variables general mood before the pandemic and change of general mood were significant in the 2020 model. In the 2021 model, only the variable general mood before the pandemic was still significant (Table 7).

Table 7

Regression coefficients for illicit drug use frequency controlling for pre-pandemic drug use

Model	Coefficients	Beta
2020	Mean mood pre-pandemic	-0.035**
	Change in mood	0.031*
	Mean drug use pre-pandemic	0.676***
2021	Mean mood pre-pandemic	-0.042**
	Change in mood	0.025
	Mean drug use pre-pandemic	0.568***

Notes: *Beta.* = Standardized regression coefficient. * p < .05 ** p < .01 *** p < .001.

Controlling for cofounders

The R^2 for the overall 2020 model was .042 (adjusted R^2 = .040) and for the 2021 model .027 (adjusted R^2 = .025), both indicative for a small overall explained variance (Cohen, 2013). The models (2020 and 2021) were able to statistically significant predict frequency of illicit drug use in 2020 (F (7, 3179) = 19.817, p < .001) and 2021 (F (7, 3175) = 12.599, p < .001).

The standardized regression coefficient of the variable general mood before the pandemic was still significant in both models and no significant effect was found for change in general mood. Urban character of place of residence, origin, level of education and age

were significant coefficients in the 2020 model, whereas in the 2021 model only urban character of place of residence and level of education were significant coefficients (Table 8). Anyhow, no change for both variables (mean mood pre-pandemic and change in mood) was found when compared to the first analysis.

Table 8

Regression coefficients for illicit drug use frequency controlling for cofounders

Model	Coefficients	Beta
2020	Mean mood pre-pandemic	-0.148***
	Change in mood	0.016
	Civil status	-0.021
	Place of residence	-0.060**
	Origin	0.054**
	Level of education	-0.058**
	Age	-0.038*
2021	Mean mood pre-pandemic	-0.130***
	Change in mood	0.021
	Civil status	-0.008
	Place of residence	-0.041*
	Origin	0.034
	Level of education	-0.050**
	Age	-0.030

Notes: *Beta.* = Standardized regression coefficient. * $p < .05$ ** $p < .01$ *** $p < .001$.

Discussion

In this study, the adaption of the self-medication hypothesis during the Covid-19 pandemic to a population sample was examined using the analysis of the influence of mood on substance use. The findings can be summarized as follows: The pandemic had a small significant influence on the mood and the frequency of substance use of the participants. The influence of mood on substance use could be partly proven but was very small. Pre-pandemic substance use was shown to be the best predictor for later substance use for all substances and timepoints. Therefore, the self-medication hypothesis cannot be supported in this study. In the following all results will be discussed in detail.

Hypotheses one and two can be partly confirmed. Even though, the changes found were all relatively small. General mood showed a small decrease in 2021 for the Dutch population compared to before the Covid-19 pandemic and compared to the beginning of the pandemic (2020). Frequency of alcohol consumption increased for the Dutch population during the Covid-19 pandemic (2020 and 2021) compared to before the Covid-19 pandemic (2018 and 2019). Yet, the amount of alcohol consumption did not increase during the pandemic compared to before the pandemic but decreased in 2020 and illicit drug consumption was stable across all four years.

In particular, the changes in the mood of the participants seem surprising. For example, the research described showed that there was a significant increase in depressive symptoms and mood disorders, particularly immediately after the outbreak of the pandemic (Robinson et al., 2022). However, this change returned to pre-pandemic levels within a few months. Robinson therefore concluded that the early stages of a pandemic are often more stressful than later stages. This effect could not be shown in this study. Rather, only in 2021 (one year after the outbreak of the pandemic) was there a significant drop in general mood in the sample studied. An adaptation to the circumstances could therefore not be demonstrated in relation to the general mood of the participants; rather, the outbreak of the pandemic does not appear to have had any significant influence on mood immediately after the outbreak. This effect might be related to the longitudinal nature of the study and the used mood variable when compared to the study of Robinson et al. As this study used a general self-rated mood for the past year immediate effects of the pandemic might have been ruled out.

Changes in the frequency of alcohol consumption could be detected. A closer look at the results, however, reveals a more general upward trend. It is therefore questionable to what extent the reasons for the further increase in the frequency of alcohol consumption are to be found exclusively due to the outbreak of the Covid-19 pandemic and that not rather several

factors had an influence on the development. The results of the analysis of the amount of alcohol consumption confirm this theory. Alcohol consumption in relation to quantity decreased significantly in 2020. This effect could be related to the fact that large quantities of alcohol are more often consumed in social settings, promoting a greater consumption of alcohol. In fact, studies confirm that social drinking (drinking in community) has a significant impact on the amount of alcohol consumed (Tomaszewski et al., 1980). In summary, it can be stated for alcohol consumption that consumption patterns based on a large but irregular consumption of alcohol have decreased. However, consumption patterns that show a regular, slowly increasing consumption of alcohol have increased (so-called level drinking) (Wetterling et al., 1999).

The results around illicit drug use did not show any change over the analyzed period. This could be because some people have reduced their consumption and others have increased their consumption. This pattern has already been described by the National Drug Monitor (Nationale Drug Monitor, 2021). In the case of illegal drug use, response behavior in the sense of social desirability is also to be expected. The social desirability bias describes the tendency to give socially desirable answers in questionnaires, which is why answers that are not socially desirable (such as the use of prohibited substances in this case) are less likely to be answered honestly (Grimm, 2010). This becomes particularly clear when looking at the frequencies of reported illicit drug use. These are clearly lower than, for example, published in the national drug report. In the sample, the reported share of drug users is about 6%, whereas cannabis alone is already used by about 16% of the people in the Netherlands, according to the Drug Report (European Monitoring Centre for Drugs and Drug Addiction, 2017).

As with hypothesis one and two, hypothesis three can be partly confirmed. There was a significant negative but small relation between frequency of alcohol consumption and illicit

drug use with general mood during all timepoints. However, amount of alcohol consumption showed no significant relation with general mood on all timepoints. In fact, there seems to be a significant negative correlation between the frequency of substance use and general mood. However, a closer look at the effects shows small correlations for both associations. Thus, it remains questionable to what extent mood had such a large influence on substance use that one can speak of a relevant influence variable. This could be because mood was primarily used in this study as average mood over a long period of time. However, subjective mood seems to lead to increased substance use primarily in the short term. Studies have shown that negative emotional states are one of the main reasons for relapse into substance use among addicts (Hodgins et al., 1995). However, these negative emotional states are often short-term and not comparable to a subjective assessment of mood over a longer period. Negative emotional states affect almost everyone more frequently in the year, but few people seem to react to them with harmful substance use. Influencing factors such as one's own impulse control may be of greater importance than mood alone. Therefore, the influence of mood can be described as primarily short-term and possibly necessary but not sufficient alone for substance use.

Finally, hypothesis four can be confirmed partially. General mood before the pandemic was able to statistically significant predict frequency of alcohol consumption in 2020 and 2021. Change in general mood was only able to significantly predict frequency of alcohol consumption in 2021. This may be since there was no significant change in the general mood in 2020. However, after a regression analysis was carried out again for potential cofounding variables, the change in mood did not become significant in the 2021 model either. Therefore, it can be assumed that only pre-pandemic mood seems to have had a small but significant predictive power on the frequency of alcohol consumption. Furthermore, a look at the cofounding variables is interesting. In particular, the influence of the level of

education was stronger than that of mood on the frequency of alcohol consumption in both models. This confirms previous research, which states that a higher level of education is also associated with lower alcohol consumption (Crum et al., 1993). The reasons for this may lie in better education about the consequences of excessive alcohol consumption and more opportunities to react productively to a bad mood. It has also been shown in studies that a higher level of education can also be seen as a protective factor for various mental illnesses. In particular, the higher sense of mastery (i.e. a sense of having control over the forces that affect one's life) seems to be strengthened by education and is seen to have a positive influence on dealing with difficult life situations (Dalgard et al., 2007). The age of the persons also seems to have had an influence on the frequency of alcohol consumption. Thus, a higher age contributed to a significantly lower frequency of alcohol consumption. A study was also able to show this effect. Especially the long-term consequences of increased alcohol consumption could contribute to this effect (Moore et al., 2005).

The only models that had strong predictive power were those that also included prior substance use. In these models, more than 75% of the variance in the frequency of alcohol consumption could be explained (in comparison to the original model: 1.3 - 1.5%). Alcohol consumption thus seems to be a very stable phenomenon and even if individual variables seem to have an influence, the best predictor for future alcohol consumption is past alcohol consumption. The effect that past behavior is one of the best predictors of future behavior has been researched and confirmed in psychological research for several decades (Ouellette & Wood, 1998). In this study, too, it could thus be proven for the frequency of alcohol consumption. However, alcohol consumption also reveals a major social phenomenon, because as with all harmful behaviors, it is usually the quantity that makes the poison.

The results for illicit drug use show a similar pattern. However, for illicit drugs, the influence of the change in mood has not been significant in any of the models (including

2021). Only pre-pandemic mood had a significant, albeit small, predictive power in predicting the frequency of illicit drug use. The percentage of variance explained was twice as high as for the frequency of alcohol consumption but can also be described as negligible. As already described for alcohol consumption, the models only became significantly more predictive when past substance use was included. Thus, both models could explain more than 30% of the variance of illicit drug use in 2020 and 2021. In both models, the pre-pandemic mood also remained significant; in the 2020 model, even the change in mood became significant. However, low influencing variables are still visible for both variables. Therefore, also in the case of drug use, past use behavior emerges as the best predictor for future substance use.

In summary, no support for the self-medication hypothesis during the Covid-19 pandemic can be expressed in this study. Changes in mood and substance use were observed but these were smaller than initially expected. Furthermore, mood correlated with frequency of substance use during all timepoints, but correlations were also smaller than expected. Regarding a predictive power of mood on substance use other factors had a much stronger influence on substance use in this study. Self-medication with the help of substances may be a phenomenon, especially in the short term or in clinical samples, but it could not be proven during the Covid-19 pandemic for a population sample.

Strengths and Limitations

It is important to note the strengths and limitations of this study. The study used a very large sample in a longitudinal design which makes the results representative. However, a large part of this sample (n = 6490; 66%) was excluded from the analysis. Especially for the variables civil status, urban character of place of residence, origin, level of education, and age significant differences between the original dataset representative of the Dutch population and the sample used have been found. As discussed previously especially age and level

education might have an influence on substance use (Dalgard et al., 2007; Moore et al., 2005). The variables were subsequently included in the regression analysis as a control, but it is not possible to say completely to what extent the sample used can be seen as representative for the Dutch population.

Furthermore, the previously described social desirability in the results must be considered. For example, some participants might have been uncomfortable admitting that the pandemic had also led to increased substance use among them. This might have influenced analysis results, as changes of substance use might have appeared smaller than they were.

The study design might also have had an influence on the results. Regarding the primary variables used in the analysis mood, and substance use, it seems questionable to what extent the persons can accurately describe substance use or mood over the past 12 months. Here, a more frequent questioning of substance use, and mood (state mood) would be helpful, especially for future research. This would also allow a more precise description of the course of consumption and mood. However, there might also be certain classes of people with different mood levels. The study indeed found small but significant effects for pre-pandemic mood showing that certain stable low moods might influence substance use. As this study did not check for certain groups, results might have been diminished.

Implications for future research and practice

For future research, a more frequent survey of mood and substance use should be conducted. Furthermore, mood should be recorded more multidimensionally and possible factors influencing it should be related to the results (such as crises or life events). In conclusion, it can be said that the increasing consumption of alcohol and drugs should be viewed critically and that measures such as an advertising ban on alcoholic beverages or better information programs for the youth should be more strongly focused on in the political

debate. Regarding an influence of the pandemic this study did not find large influences of the pandemic on the people's mood, even if significant differences were found. Most people seem to have coped with the challenges of the pandemic well. Future research should find out which factors might have helped in coping with the pandemic, and which can be seen as risk factors. Lastly, regarding the self-medication hypothesis it seems to be the case that it can only be applied to a clinical sample. People that are already suffering from mental health problems might be keener to cope in an unhealthier way compared to the public.

Conclusion

As a conclusion, it can be stated that the influence of the pandemic on the participants general mood was considerably lower than expected, even though significant differences were found. General mood seems to be a very stable phenomenon, at least in this study. Anyhow, general mood seems to have a significant influence on all forms of substance use, but this influence is remarkably lower than postulated by the self-medication hypothesis. Other variables had a stronger influence on consumption behaviour in this study. Thus, especially in the case of alcohol consumption, the level of education and the age could be identified as significant influencing factors. Anyhow, especially previous substance use was identified as the main factor influencing substance use.

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Tables

Table A1

Descriptive statistics

Variables		Statistic	Excluded sample	Used sample
Level of education	Primary school	Count	1288	183
		%	21,7%	5,6%
	VMBO	Count	901	702
		%	15,2%	21,3%
	HAVO/VWO	Count	589	318
		%	9,9%	9,7%
	MBO	Count	1217	807
		%	20,5%	24,5%
	HBO	Count	1219	873
		%	20,6%	26,5%
	WO (university)	Count	716	408
		%	12,1%	12,4%
Origin	Dutch background	Count	2938	2701
		%	77,3%	84,0%
	First generation foreign	Count	396	258
		%	10,4%	8,1%
	Second generation foreign	Count	468,0	256,0
		%	12,3%	8,0%
Urban character of place of residence	Extremely urban	Count	1098	516
		%	17,1%	15,7%
	Very urban	Count	1297	709
		%	20,2%	21,6%
	Moderately urban	Count	1093	617
		%	17,0%	18,8%
	Slightly urban	Count	1419	652
		%	22,0%	19,9%
	Not urban	Count	1529	786
		%	23,8%	24,0%
Civil status	Married	Count	2338	1918
		%	36,0%	58,1%
	Separated	Count	13	12
		%	0,2%	0,4%
	Divorced	Count	363	369
		%	5,6%	11,2%
	Widow or widower	Count	147	246
		%	2,3%	7,5%
	Never been married	Count	3629	754
		%	55,9%	22,9%

Variable	Sample	N	Mean	SD
Age	Used sample	3299	58,58	16,63
	Excluded sample	6490	37,03	22,28

Table A2

Correlations between amount of alcohol consumption and general mood at measurement timepoints.

		General mood 2018	General mood 2019	General mood 2020	General mood 2021
Amount alcohol 2018	Correlation coefficient	-0,019			
Amount alcohol 2019	Correlation coefficient	-0,025	-0,040		
Amount alcohol 2020	Correlation coefficient	-0,018	-0,041	-,077**	
Amount alcohol 2021	Correlation coefficient	-0,026	-,059*	-0,045	-0,023

Notes: Correlation was calculated using Pearson product moment correlation. *Sig.* = Significance. *Freq.* = Frequency * $p < .05$ ** $p < .01$ *** $p < .001$