The effect of mental health on drug use: evidence from the Dutch population

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Abstract

This paper researches the effect of mental health on drug use in the Netherlands. Additionally, it is investigated if the effect differs for people with different sexes and from different age groups. A regression with individual and wave fixed effects is used to answer the research question. To combat reverse causality, an instrumental variable is added to the regression. The sex and age effects are measured with use of a sex and an age interaction effect. While there were no significant results found for hard drugs and hallucinogens as outcome variables, there were highly significant results when any drugs and soft drugs were the outcome variables. Based on those results, it can be concluded that mental health has a small but negative effect on the probability that someone uses drugs. Moreover, the effect of mental health on drug use is bigger for females than for males and it is increasing with age. It can also be concluded that the instrumental variable was not good, which means that reverse causality might be at play in this research.

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1. Introduction

"Drug addiction is a chronic relapsing disorder characterized by compulsive drug intake, loss of control over intake, and impairment in social and occupational function" (Koob et al., 2004).

According to Koob et al. (2004), when looking at drug use from a psychological perspective, it has aspects of both impulse control disorders and compulsive disorders. In the first stage, drug use can be seen as an impulse disorder, which is driven by positive reinforcement. Someone has a feeling of tension or arousal, acts impulsively by taking drugs and feels a form of relief and/or pleasure. Afterwards, feelings of regret can arise. However, when people move to the second stage, drug use shows more similarities with a compulsive disorder, which is driven by negative reinforcement. In this situation, someone feels stressed or struggles with anxiety, takes drugs by means of stress/anxiety relief and then becomes obsessed with drugs because of the relief it gives them (Koob et al., 2004).

Drug use can also be explained from a biological perspective. Most of the drugs affect the brain's reward circuit, giving them the feeling of euphoria combined with the release of dopamine. The release of dopamine encourages people to reinforce their behaviors, leading to repeated drug use. When someone continuously uses drugs, they build up a tolerance for its effects. This means that the feeling of euphoria decreases, which can lead to an increase in the amount of drugs used, to reach the same high. These changes in the brain also lead to a situation where people are less able to find pleasure in other things, such as social activities or hobbies (National Institute on Drug Abuse, 2018).

The consequences of drug use are also visible in the work environment. Normand, Salyards and Mahoney (1990) researched the effect of drug use on work behavior in the United States. They found that people who used illicit drugs had absenteeism rates that were 59.3% higher than people who did not use illicit drugs. Moreover, their involuntary turnover rate, which was used as a measure of work performance, was 47% higher. Frone (1998) also researched the effect of drug use on work behavior in the United States. He found that on-the-job drug use was positively related to work injuries.

Clearly, drug abuse has numerous negative effects on someone's life. In addition to the personal negative effects, it also has a societal cost. Rivera, Casal and Currais (2017) researched the social cost of drug use in Spain in 2012. They found that there were around 123 thousand cases of hospitalizations where drug use was related to the main or secondary diagnosis. In addition, almost 230 thousand drug related appointments were made in primary and emergency care. Drug use was directly responsible for 370 premature deaths and indirectly for another 571. Lastly, there were almost 22 thousand judicial procedures involving drug trafficking, over 17 thousand of which were imprisoned. Altogether, the total societal cost of drug use was somewhere around 1.5 million euros.

Drug use has multiple negative effects on a personal, work and societal level. Finding out what the causes of drug use are, is the first step of stopping drug use in the Netherlands.

In their research on why adolescents use drugs, Novacek, Raskin and Hogan (1991) found that drug use can be allocated to five different reasons. These are belonging, coping, pleasure, creativity and aggression. In their research, the authors asked middle and high school students why they (would) use drugs. Some of the most frequently chosen answers were because the person in question was depressed, to escape from problems, to relieve nervousness and to relax. While belonging (e.g., doing it because friends also do it) was the main category, coping (e.g., doing it because someone was depressed or feeling down) was the second biggest category. The research shows that there might be a link between drug use and mental health. That is why the following question will be researched in this paper:

How does mental health affect the drug use of the Dutch population?

There is a broad literature available on the association between mental health and the use of drugs, which will be addressed in the literature review in subsection 2.1. This research is unique because it researches drug use in a relatively tolerant country in terms of drug use and because it researches the effect of mental health on different kinds of drugs. Additionally, this paper aims at finding a causal effect while most other researchers' main focus was to find associations. This research also has a high societal relevance. The more that is known about the causes of drug use, the more can be done to prevent it. In addition, if this research does find that mental health has a negative effect on drug use, the importance of providing good mental health care is emphasized.

In this paper, the effect of mental health on the probability that someone uses drugs is investigated. Mental health is measured on a scale of 1 (poorest) to 6 (best) and the four outcome variables in this research are drugs in general, soft drugs, hard drugs and hallucinogens. Additionally, it is investigated if there are gender and age differences, by using an interaction term between mental health and gender and age, respectively. The first lag of mental health is used as an instrumental variable to combat reverse causality and endogeneity.

The paper makes use of data from the Dutch LISS panel on mental health and drug use. The data is longitudinal and is collected from 2007 until 2021. The panel data allows for the use of two-way fixed effects, namely individual and wave fixed effects.

The results show that the estimation model without the IV appears to be more reliable and less biased than the estimates from the model with the IV. Moreover, the results yield significant estimates for drug use in general and the use of soft drugs, but not for hard drugs and hallucinogens as outcome variables. From the results can be concluded that the effect of mental health on drug use is small and negative, and that the effect is bigger for females than for males. Additionally, the effect of mental health on drug use increases with age.

In the rest of the paper, there will first be a literature review and other background information. Then, the data collection and adjustments are explained, after which the methodology is described. Then, the results for all four outcome variables are shown and interpreted. This paper ends with a summary and conclusion, a discussion on the paper's validity and limitations and recommendations for future research and policy.

2. Background

2.1 Literature review

While the causal effect of mental health on drug use has not been researched yet, there is earlier work on the association between the two. Sullivan, Edlund, Zhang, Unützer and Wells (2006) researched the association between mental health, drug use and prescription opioids use in the United States. Opioids are a class of drugs that includes painkillers such as morphine and are available by prescription (National Institute on Drug Abuse, n.d.). The analysis showed that mental disorders were associated with both initiation and continuation of opioids. In addition, patients that received opioids were two to three times more likely to report a need for mental health treatment. In research by Moore et al. (2007), different datasets on drug use and mental health were used simultaneously. The results show a consistent association between the use of cannabis and psychotic symptoms. The authors were able to conclude from these findings, that using cannabis could increase one's risk in developing a psychotic illness. On the contrary, Cranford, Eisenberg and Serras (2009) did not find statistically significant associations between marijuana use and mental health problems, when researching those associations under American college students.

Research by Van Ours and Williams (2012) on the effect of cannabis use on mental health took place in the Netherlands, just like the research that will be conducted in this paper. The authors found evidence that cannabis use reduces the mental wellbeing of both males and females. However, they do note that reverse causality might lead to overestimation of the causal impact of cannabis use on mental health.

Sullivan et al. (2006) found that poor mental health is associated with drug use and Moore at al. (2007) found that drug use is associated with poorer mental health. Van Ours and Williams (2012) focused on finding a causal effect of drug use on mental health and found a negative effect, however stating that reverse causality may be at play. There is very little research done yet on the causal effect of mental health on drug use, but the papers mentioned above do indicate a negative effect between the two. Moreover, the negative effect appears to be working both ways. Since the aim of this paper is to find a possible cause of drug use, the following is hypothesized:

People with poorer mental health are more likely to use drugs than people with better mental health.

The first hypothesis is also consistent with the study performed by Schwinn, Schinke and Trent (2010). When researching gender and mental health effects on substance use in American youth, they were able to conclude several things. Firstly, there were no gender differences in terms of drug use. Secondly, females reported higher levels of both depression and anxiety, indicating that females had more mental health problems than males. Thirdly, increased levels of depression and anxiety predicted increased drug use across genders. The data thus provides evidence that mental distress may be associated with increased drug use. Lastly, the data did not show that gender moderated the relationship between mental health and drug use. Unlike their paper, this research will focus on a broader population than just the youth. Therefore, it interesting to add the sex distinction, even though Schwinn et al. (2010) did not find gender differences. The second hypothesis, which is based on their findings, is:

The effect of mental health on the probability of drug use is similar for males and females.

There is very little literature available on the effect of mental health on drug use for different age groups. Therefore, adding an age distinction in this research is an interesting addition. Research by Pearson, Janz and Ali (2013) showed that people aged 15-24 are more likely to have a mental disorder and/or use substances than any other age group. Moreover, they found that the percentage of people with mood and substance use disorders was lower for older age groups. The authors state that their findings are in line with other studies, which focused on either mental health or substance use. Pearson et al. (2013) did not actually research the link between mental health and drug use, so there is no literature available on this effect with an age distinction. Therefore, the fact that the youth is the most likely to have a mental disorder and/or use substances is the most relevant information that can be and thus will be used to hypothesize the following:

The effect of mental health on the probability of drug use decreases with age.

2.2 Drugs in the Netherlands

The Dutch Opium Law is the law concerning drugs in the Netherlands. The law came into effect in 1928 and replaced the previous Opium Law. It makes a distinction between soft and hard drugs. On list I, all hard drugs are listed. These drugs are considered more dangerous and more harmful for someone's health than soft drugs. On list I are, among others, heroin, cocaine, amphetamine, ecstasy and GHB. All soft drugs such as cannabis products (e.g., hash and weed), sleeping pills and sedatives are on list II. Most hallucinogens, such as psilocybin mushrooms, are also on list II. The use of two lists makes it possible to apply different rules and penalties, in case of a violation, for different kinds of drugs. The Opium Law states that everything that can be done with drugs, with the exception of their use, is illegal. This list of illegal actions includes, but is not limited to, dealing, producing, growing and transporting drugs (Opiumwet, 2021). However, under strict conditions, the sale of soft drugs is tolerated in coffee shops. These conditions include that it is not allowed to sell drugs to minors or to advertise the sale of it (Ministerie van Justitie en Veiligheid, 2019). In addition, the possession of drugs, provided that the amount is minimal, is tolerated in the Netherlands (Jellinek, 2020). As Leuw (1991) explained, "illegal drugs are seen as a limited and manageable social problem rather than an alien threat forced on an otherwise innocent society". The author furthermore explains that the Netherlands made a conscious decision to tolerate drugs in order to reduce the risks of drug addiction. Moreover, it is believed that attempts to eradicate drugs does more harm to society than good (Leuw, 1991). Because drug use is tolerated and people do not have to engage in illegal behaviors to use drugs in the Netherlands, the country is an interesting one to research the causes of drug use.

3. Data

This research contains several terms of which it is important to know what they mean. Therefore, those terms will now be explained. Mental health is the "health of the mind as a distinct from physical health" (Oxford University Press, n.d.). In other words, mental health describes how healthy people are psychologically and emotionally, rather than physically. In this paper, mental health will be proxied by someone's mood in the past month. The types of drugs of which the usage will be measured are sedatives, soft drugs, hallucinogens, ecstasy and hard drugs. The distinction between and explanation of soft drugs and hard drugs is already given in section 2.2. Sedatives are a type of drugs that have a soothing property (Oxford University Press, n.d.). They are often prescribed by doctors when people

suffer from anxiety or sleeping disorders (Healthline, 2019). Hallucinogens are drugs that cause hallucinations (Oxford University Press, n.d.). When MDMA is used in the form of a pill, it is referred to as ecstasy. When it is in powder or crystal form, it is often referred to as MDMA. Ecstasy gives most people extra energy and puts them in a state of excitement (XTC (MDMA): wat je moet weten, 2022).

In this paper I make use of data of the LISS (Longitudinal Internet Studies for the Social sciences) panel administered by Centerdata (Tilburg University, The Netherlands). The LISS panel is a representative sample of the Dutch population. The longitudinal data of the health study will be used to answer the research question. Within this dataset, there are questions that ask respondents about their mood in the past month. The same dataset also holds information about the respondents' use of different kinds of drugs. The study is longitudinal, meaning that there are 14 years in which the same survey was filled in. Most respondents participated in multiple waves, so changes in their drug use and mental health are measured. The first wave took place in the winter of 2007/2008 and the fourteenth wave took place in the winter of 2021. There was no data collected in 2014. Wave 8, taking place in 2015, is the only wave in which the data was collected in the summer, rather than in the winter. Each wave is a separate dataset, and these datasets can be matched with others via a personal identifier. The personal identifier also makes it possible to match datasets of the health study with datasets that hold background variables, such as age and gender.

Wave 8 will be deleted from the dataset for several reasons. Firstly, the expectation is that the average mental health in wave 8 will be higher than in other waves, due to winter seasonal affective disorders (winter SAD). Winter SAD is characterized by recurrent depressive episodes in the winter. While for most people the condition is not that severe, impairment of functioning at work and in social relations are common consequences. Approximately 0.8% to 1.2% of the general population is at risk of SAD (Partonen & Lönnqvist, 1998). Additionally, about 10% to 20% may have mild SAD, also known as the winter blues ("Seasonal Affective Disorder," 2000). Secondly, drug use is different in different seasons. Lipari (2015) researched substance use initiation in college students. She found that initiation of alcohol, cigarettes and marijuana, among others, peaked in June and July. Because both mental health and drug use are different in the summer compared to the winter, wave 8 of the dataset will be removed.

After removing wave 8, 15,016 individuals are left in the dataset. Table 1 shows in which period each survey wave was answered, as well as the number of observations, the mean age and the proportion of the respondents that is male.

Table 1

Sample descriptive statistics

Wave	Period	Observations	Mean age	Male
1	Winter 2007/2008	6,645	45.295	0.4624
2	November & December 2008	5,943	46.454	0.4591
3	November & December 2009	6,091	48.192	0.4632
4	November & December 2010	5,688	48.921	0.4632
5	November & December 2011	5,058	49.969	0.4658
6	November & December 2012	5,763	50.147	0.4615
7	November & December 2013	5,367	50.976	0.4636
9	November & December 2016	5,386	51.794	0.4696
10	November & December 2017	5,940	51.471	0.4562
11	November & December 2018	5,475	52.195	0.4585
12	November & December 2019	5,150	52.960	0.4668
13	November & December 2020	5,719	52.423	0.4606
14	November & December 2021	5,095	53.677	0.4630

Note. Male is the proportion of respondents in the wave that is male.

Table 2 shows for each type of drug, how many people said they used it. The information is shown as number of observations as well as in percentages. Moreover, the number of users is given per subgroup. Please note that the variables are the sum of all waves together, so the values show how many times people reported to have used drugs in all 13 waves. As can be seen in the table, there are not many respondents that have used hard drugs and hallucinogens.

Table 2

Drug use per subgroup

		All	Sex		Age		
			Male	Female	≤ 25	25-50	≥ 50
Any drugs	Yes	4819	2278	2541	944	1779	2096
		(6.57%)	(6.72%)	(6.45%)	(11.57%)	(6.87%)	(5.34%)
	No	68503	31641	36862	7212	24133	37158
		(93.43%)	(93.28%)	(93.55%)	(88.43%)	(93.13%)	(94.66%)
	Total	73322	33919	39403	8156	25912	39254
Soft drugs	Yes	4448	2062	2386	847	1538	2063
		(6.07%)	(6.08%)	(6.06%)	(10.38%)	(5.94%)	(5.26%)
	No	68874	31857	37017	7309	24374	37191
		(93.94%)	(93.92%)	(93.94%)	(89.62%)	(94.06%)	(94.74%)
	Total	73322	33919	39403	8156	25912	39254
Hard drugs	Yes	758	486	272	221	423	114
		(1.03%)	(1.43%)	(0.69%)	(2.71%)	(1.63%)	(0.29%)
	No	72562	33432	39130	7935	25489	39138
		(98.97%)	(98.57%)	(99.31%)	(97.29%)	(98.37%)	(99.71%)
	Total	73320	33918	39402	8156	25912	39252
Hallucinogens	Yes	157	108	49	61	51	45
		(0.21%)	(0.32%)	(0.12%)	(0.75%)	(0.20%)	(0.11%)
	No	73163	33810	39353	8095	25861	39207
		(99.79%)	(99.68%)	(99.88%)	(99.25%)	(99.80%)	(99.89%)
	Total	73320	33918	39402	8156	25912	39252

Table 3 shows what the average health score is for the whole sample and for each subgroup.

Table 3

Average mental health scores per subgroup

	All	Sex		Age		
		Male	Female	≤ 25	25-50	≥ 50
Average mental health	4.711	4.809	4.626	4.468	4.632	4.813

To get a dataset that can be used for analysis, several things in the LISS datasets need to be adjusted. Both the adjustment and analysis of the data will be done in the software program Stata.

Firstly, the questions about the self-reported mood need to be adjusted. In the original datasets, there are 5 questions about the self-reported mood:

In the past month… I felt very anxious.

I felt so down that nothing could cheer me up.

I felt calm and peaceful.

I felt depressed and gloomy.

I felt happy.

The answer options to these questions are 1. Never 2. Seldom 3. Sometimes 4. Often 5. Mostly and 6. Continuously. For the first, second and fourth question, a higher value is negative while for the third and fifth question, a higher value is positive. By switching the values for question one, two and four (i.e., 1 becomes 6, 2 becomes 5, 3 becomes 4, 4 becomes 3, 5 becomes 2 and 6 becomes 1), a higher value is an indicator for a good mental health in all the questions. Then, the average of the five questions will be calculated to get a mental health score on a scale from 1 (poor mental health) to 6 (good mental health).

Secondly, the question about the drug use of the respondents needs to be adjusted. The question asks if the respondents used any of the following drugs: sedatives, soft drugs, ecstasy, hallucinogens and hard drugs. If the answer to the question is never, the value will be made 0. If the answer is either sometimes or regularly, the value will be made 1. By doing this, a binary variable is created that measures if someone used drugs in the past month or not. Since sedatives are considered to be soft drugs in the Netherlands (i.e., they are on list II), the sedatives and soft drugs questions will be combined to one soft drugs variable. Ecstasy is on list I and will therefore be combined with the hard drugs variable. Hallucinogens are more difficult to categorize, since it covers multiple drugs. LSD is a drug that is categorized as a hallucinogen and is on list I of the Opium Law. Magic mushrooms however are on list II. Therefore, hallucinogens will remain a separate variable. MDMA can be considered hallucinogen, but it is included in the hard drug variable for two reasons. Firstly, it is in line with the original survey from LISS, where MDMA is specifically named as a form of ecstasy, making it part of the ecstasy variable. Secondly, MDMA is not considered a classic hallucinogen. Classic hallucinogens exert effects through the 5-HT2A receptor. Evidence shows that 5-HT2AR is the most important receptor that causes psychedelic effects. MDMA causes psychedelic effects through serotine release instead of

through the 5-HT2A receptor (Johnson, Hendricks, Barrett & Griffiths, 2019). For those two reasons, MDMA is included in the hard drug variable instead of the hallucinogen variable.

There is no variable available on the respondents' age, but their year of birth is available. By subtracting the year of birth from the year of the survey, the age is calculated. This calculation can be used because the surveys take place in the last two months of each year. However, it is important to note that some people have not had their birthday yet at the time of the survey. That means that their actual age is a year lower than what is stated in the dataset. However, there is only a small proportion of respondents whose birthday is after the moment of the survey, so the actual average age will not deviate much from the calculated average age. Moreover, age will be used in the regression as a categorical variable, so the chance that someone is in the wrong age group, due to this method of calculating the age, is very small and therefore the chosen method is not problematic.

4. Methodology

4.1 Method

The effect of mental health on drug use will be estimated by using Ordinary Least Squares (OLS) regression with individual and wave fixed effects. In addition, separate analyses with interaction effects will be added to investigate if the effect size differs for people with different sexes and different ages. The individual and fixed wave effects are added to control for variables that are constant across individuals (e.g., genes like addiction sensitivity) and to control for wave effects that are fixed across all individuals (e.g., the covid-19 pandemic).

There is a high probability of reverse causality and/or simultaneity, meaning that it is unclear if drug use affects mental health or the other way around, or if they simultaneously influence each other. An instrumental variable (IV)[1] can be used to counteract this. The IV should have a causal effect on mental health, should not have a direct effect on drug use and should be uncorrelated with any other determinant of drug use (i.e., uncorrelated with the error term). The IV that will be used in this research is the first lag of mental health. The intuition behind this is that someone's former mental health has a causal effect on their current mental health, does not directly influence current drug use and is uncorrelated with the error term. It counteracts reverse causality and simultaneity because it is very unlikely that someone's current drug use affects their former mental health (i.e., the past cannot be caused by the future). In addition to the intuitive explanation as to why a lagged IV works, Reed (2015)

[1] Instrumental variable, IV, instrument, first lag of mental health and lagged mental health will be used as synonyms throughout the paper.

proved that using a lagged variable as an IV works if X_t and X_{t-1} are highly correlated. Current mental health and its first lag have a correlation of 0.6536, which indicates that the first lag of mental health is a proper IV.

The usage of both individual and wave fixed effects and the use of an IV are two ways to increase the probability of getting a causal effect. Firstly, the fixed effects control for many observable and unobservable characteristics, which reduces the probability of getting spurious findings and making incorrect causal claims. Secondly, the IV is used to counteract reverse causality. Therefore, the probability of finding causal effects in this paper is high.

4.2 Regressions

The hypotheses will be tested with two kinds of formulas that are explained below.

Firstly, an ordinary least squares (OLS)[2] regression is performed:

$$\text{Drug use}_{i,t} = \beta_0 + \beta_1 \text{Mental health}_{i,t} + \alpha_i + \delta_t + \varepsilon_{i,t}$$

In this formula, Drug $use_{i,t}$ is the probability of using 1) any drugs, 2) soft drugs, 3) hard drugs and 4) hallucinogens, respectively. Mental health is measured on a 1 to 6 scale. The variable α_i captures the individual fixed effects and δ_t captures the wave fixed effects.

Then, a second regression is performed. This is a two-stage least squares (2SLS)[3] model with one instrumental variable.

In the first stage, mental health is regressed on lagged mental health to obtain fitted values:

$$\widehat{\text{Mental Health}}_{i,t} = \gamma_0 + \gamma_1 \text{Mental health}_{i,t-1}. + \alpha_i + \delta_t + \varepsilon_{i,t}$$

Then in the second stage, the fitted values are used to estimate the effect of mental health on drug use:

$$\text{Drug use}_{i,t} = \beta_0 + \beta_1 \widehat{\text{Mental Health}}_{i,t} + \alpha_i + \delta_t + \varepsilon_{i,t}$$

To test if the effect differs for different sexes, a sex interaction effect will be added to the regressions.

The first regression is again the one that uses OLS:

$$\text{Drug use}_{i,t} = \beta_0 + \beta_1 \text{Mental health}_{i,t} + \beta_2 \text{Mental Health}_{i,t} * \text{Sex}_i + \alpha_i + \delta_t + \varepsilon_{i,t}$$

The second regression is the one with the IV. The first stage is

[2] OLS model and model without the IV will be used as synonyms throughout the paper.
[3] 2SLS model and IV model will be used as synonyms throughout the paper.

$$\widehat{\text{Mental Health}}_{i,t} = \gamma_0 + \gamma_1 \text{Mental health}_{i,t-1}. + \gamma_2 \text{Mental Health}_{i,t} * \text{Sex}_i + \alpha_i + \delta_t + \varepsilon_{i,t}$$

And the second stage is

$$\text{Drug use}_{i,t} = \beta_0 + \beta_1 \widehat{\text{Mental Health}}_{i,t} + \beta_2 \widehat{\text{Mental Health}}_{i,t} * \text{Sex}_i + \alpha_i + \delta_t + \varepsilon_{i,t}$$

If the interaction effect yields significant values, then there are sex differences.

To test if the effect differs for different age groups, an age interaction effect will be added to the basic regressions. The age groups are: Youth (25 years or younger), young adults (between 25 and 50 years old) and older adults (50 years or older).

First is the OLS regression:

$$\text{Drug use}_{i,t} = \beta_0 + \beta_1 \text{Mental health}_{i,t} + \beta_2 \text{Mental Health}_{i,t} * \text{Age}_{i,t} + \alpha_i + \delta_t + \varepsilon_{i,t}$$

Secondly, the 2SLS regression is performed. The first stage is

$$\widehat{\text{Mental Health}}_{i,t} = \gamma_0 + \gamma_1 \text{Mental health}_{i,t-1}. + \gamma_2 \text{Mental Health}_{i,t} * \text{Age}_{i,t} + \alpha_i + \delta_t + \varepsilon_{i,t}$$

And the second stage is

$$\text{Drug use}_{i,t} = \beta_0 + \beta_1 \widehat{\text{Mental Health}}_{i,t} + \beta_2 \widehat{\text{Mental Health}}_{i,t} * \text{Age}_{i,t} + \alpha_i + \delta_t + \varepsilon_{i,t}$$

Again, this analysis will be done with the probability of using any drugs, soft drugs, hard drugs and hallucinogens as outcome variables.

5. Results

In the following four subsections, the estimated effect sizes of mental health on drug use will be presented and interpreted. First, the effect of mental health on any drug use will be analyzed, then its effect on soft drugs, hard drugs and hallucinogens will follow. In each subsection, the first table shows the effect of mental health on drug use without and with an IV. The second table shows the OLS estimation and the IV estimation, with the sex effect included. The third table also shows OLS and IV estimations respectively, but with the age effect included. After each table is shown, the results are interpreted. Final conclusions per outcome variable will be drawn at the end of each subsection.

5.1 Any drugs

In tables 4, 5 and 6, the effect of mental health on drug use is presented.

Table 4

The effect of mental health on drug use

	OLS	IV
Mental health	-0.0277***	-0.1430***
	(0.0020)	(0.0263)
Constant	0.1964***	0.7383***
	(0.0094)	(0.1247)
Instrumental variable	No	Yes
Individual fixed effects	Yes	Yes
Wave fixed effects	Yes	Yes
Observations	14,693	11,260

Note. The outcome variable in this table is any drug use. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

As can be seen in table 4, the addition of the instrument, lagged mental health, has a big difference on the estimates of mental health and the constant. Without the IV, a mental health score increase of 1 decreases the probability of drug use with on average 2.77%. When the IV is added, the average estimated decrease is 14.30%. The first stage F-statistic is 161.65, which shows that the first stage is very strong. That means that the instrument has a clear and strong causal effect on the mental health variable, which is the first assumption that should hold for an IV to work properly. Both estimates are significant at the 99% significance level, so mental health seems to have a significant effect on drug use.

Table 5

Sex effects of mental health on drug use

	OLS	IV
Mental health	-0.0315***	-0.3036***
	(0.0028)	(0.0685)
Mental health * Sex		
Male	0.0090**	0.2819***
	(0.0039)	(0.0686)
Constant	0.1940***	0.8650***
	(0.0093)	(0.1708)
Instrumental variable	No	Yes
Individual fixed effects	Yes	Yes
Wave fixed effects	Yes	Yes
Observations	14,693	11,260

Note. The outcome variable in this table is any drug use. The female category is omitted. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5 shows the sex effects of mental health on drug use. In the OLS regression, an increase in mental health score of 1 point reduces the chance that someone uses drugs with on average 3.15% if they are female and with on average 2.25% if they are male. Both estimates are significant at the 95% level. For females, an increase of 1 point in mental health score decreases the probability of drug use with 30.36% on average, when an IV is added. For males, the average decrease is only 2.17%. The F-statistic of 14852.33 shows that the first stage is very strong. Again, both estimates are significant at the 99% significance level.

Table 6

Age effects of mental health on drug use

		OLS	IV
Mental health		-0.0267***	-0.1776***
		(0.0021)	(0.0359)
Mental health * Age			
Youth	(≤ 25)	0.0021	0.0090***
		(0.0019)	(0.0025)
Older adults	(≥ 50)	-0.0018**	0.0208***
		(0.0008)	(0.0055)
Constant		0.1944***	0.8402***
		(0.0094)	(0.1546)
Instrumental variable		No	Yes
Individual fixed effects		Yes	Yes
Wave fixed effects		Yes	Yes
Observations		14,690	11,255

Note. The outcome variable in this table is any drug use. The young adults category is omitted. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6 shows the age effects of mental health on drug use. When someone's mental health score increases with 1 point, the probability that they use drugs decreases with on average 2.46%, 2.67% and 2.85%, for the youth, young adults and older adults respectively. The estimates of the youth and the young adults are not significantly different from each other. Moreover, all other estimates are significant at the 95% significance level. When the instrument is added, the probability that someone uses drugs decreases with on average 16.86%, 17.76% and 15.86% for the youth, young adults and older adults respectively, when their mental health score increases with 1 point. The first stage F-statistic is 1489.66, so the first stage is strong. In this model, all three age groups differ significantly from each other. Additionally, all estimates are significant at the 99% level.

From the results in table 4, 5 and 6, the following conclusions can be drawn. Firstly, the addition of an IV drastically changes the estimates. When looking at both the constant and the point estimates, the OLS regressions appear to be more reliable than the IV regressions. With 6.57% of the whole sample saying that they used drugs in the past month, average decreases of 14.30% per 1 point increase in mental health score does not make sense. This is an indicator that the instrument is biased and

therefore so are the estimates in the IV regression. When looking at sex differences, the estimated effect of mental health on the possibility that someone uses drugs is bigger for females than for males. For the youth and young adults, the estimated effects are similar, and the estimated effect for older adults is significantly stronger. All estimates are significant at the 95% significance level, so there appears to be an actual effect of mental health on drug use, rather than that the estimates are driven by some random noise in the data. Lastly, the relationship is negative in all estimates.

5.2 Soft drugs

In tables 7, 8 and 9, the effect of mental health on soft drug use is presented.

Table 7

The effect of mental health on soft drug use

	OLS	IV
Mental health	-0.0274***	-0.1471***
	(0.0020)	(0.0257)
Constant	0.1899***	0.7531***
	(0.0093)	(0.1220)
Instrumental variable	No	Yes
Individual fixed effects	Yes	Yes
Wave fixed effects	Yes	Yes
Observations	14,693	11,260

Note. The outcome variable in this table is soft drug use. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Similar to the effect of mental health on any drug use, the addition of an IV changes the estimates of mental health on soft drug use drastically. Without the instrument, an increase in mental health score of 1 point decreases the probability of using soft drugs with 2.74% on average. With the instrument, an increase in mental health of 1 point decreases the probability of using soft drugs with on average 14.71%. As has been explained in subsection 5.1, the first stage F-statistic is very strong with a value of 161.65. Moreover, both estimates are significant at the 99% level.

Table 8

Sex effects of mental health on soft drug use

	OLS	IV
Mental health	-0.0312***	-0.3129***
	(0.0028)	(0.0679)
Mental health * Sex		
Male	0.0092**	0.2910***
	(0.0039)	(0.0680)
Constant	0.1875***	0.8839***
	(0.0091)	(0.1692)
Instrumental variable	No	Yes
Individual fixed effects	Yes	Yes
Wave fixed effects	Yes	Yes
Observations	14,693	11,260

Note. The outcome variable in this table is soft drug use. The female category is omitted. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

In the OLS estimation, an increase in mental health score of 1 point decreases the probability that a female uses drugs with on average 3.12% and decreases the chance that a male uses drugs with on average 2.20%. Both estimates are significant at the 95% level. When adding the IV, the probability that a female uses drugs decreases with 31.29% on average, when mental health score increases with 1 point. When looking at the estimated effect of a 1-point increase in mental health on the probability of using drugs for males, it decreases the probability with on average 2.19%. The F-statistic of 14852.33 shows that the first stage is very strong. All estimates are significant at the 99% significance level.

Table 9

Age effects of mental health on soft drug use

		OLS	IV
Mental health		-0.0265***	-0.1811***
		(0.0020)	(00352)
Mental health * Age			
Youth	(≤ 25)	0.0053***	0.0117***
		(0.0017)	(0.0024)
Older adults	(≥ 50)	-0.0020***	0.0210***
		(0.0007)	(0.0053)
Constant		0.1877***	0.8502***
		(0.0093)	(0.1514)
Instrumental variable		No	Yes
Individual fixed effects		Yes	Yes
Wave fixed effects		Yes	Yes
Observations		14,690	11,255

Note. The outcome variable in this table is soft drug use. The young adults category is omitted. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

First, the results from the OLS model are interpreted. For the youth, an increase in mental health score of 1 point yields an average decrease in the probability of using drugs of 2.12%. For young and older adults respectively, the percentages are -2.65% and -2.85%. The estimates are all significant at the 99% significance level. Now, the results from the IV model are interpreted. When someone's mental health score increases with 1 point, the probability that they use drugs decreases with on average 16.94% if they are 25 years or younger, 18.11% if they are between 25 and 50 years old and 16.01% if they are 50 years or older. Again, the F-statistic of 1489.66 shows a strong first stage. All estimates are significant at the 99% level.

The effect of mental health on soft drug use is very similar to the effect of mental health on any drug use. Firstly, all estimates are again negative and significant at the 95% significance level. Secondly, adding an IV seems to bias the estimates, making the estimated effects much bigger than they realistically should be. Thirdly, when interpreting the OLS estimates, the estimated effect of mental health on the probability of using drugs is bigger for females than for males. The estimates are

significantly different for all age groups, with the estimated effect being the strongest for the older adults.

5.3 Hard drugs

In tables 10, 11 and 12, the effect of mental health on hard drug use is presented.

Table 10

The effect of mental health on hard drug use

	OLS	IV
Mental health	-0.0003	0.0084
	(0.0007)	(0.0103)
Constant	0.0119***	-0.0303
	(0.0032)	(0.0489)
Instrumental variable	No	Yes
Individual fixed effects	Yes	Yes
Wave fixed effects	Yes	Yes
Observations	14,692	11,260

Note. The outcome variable in this table is hard drug use. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 10 shows the estimated effect of mental health on the probability of using hard drugs, without and with an IV. Without the instrument, an increase in someone's mental health score of 1 point is associated with a 0.03% decrease in probability that they use hard drugs, on average. With the instrument, a 1-point increase in mental health score is associated with a 0.84% increase in the probability of using hard drugs, on average. As has been explained in subsection 5.1, the first stage F-statistic is very strong with a value of 161.65. Both estimates are insignificant, so it is unclear if there is an actual relationship between mental health and drug use or if the estimates are driven by random noise in the data.

Table 11

Sex effects of mental health on hard drug use

	OLS	IV
Mental health	-0.0007	0.0153
	(0.0007)	(0.0240)
Mental health * Sex		
Male	0.0009	-0.0122
	(0.0015)	(0.0240)
Constant	0.0117***	-0.0358
	(0.0034)	(0.0598)
Instrumental variable	No	Yes
Individual fixed effects	Yes	Yes
Wave fixed effects	Yes	Yes
Observations	14,692	11,260

Note. The outcome variable in this table is hard drug use. The female category is omitted. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

For females, an increase of 1 point in the mental health score is associated with an average decrease of 0.07% on the probability that someone uses hard drugs. For males, an average increase of 0.02% is estimated. Neither estimates are significant. When the IV is added, the point estimates are 1.53% and 0.31% on average, for females and males, respectively. The F-statistic of 14852.33 shows that the first stage is very strong. However, these estimates are again not significant.

Table 12

Age effects of mental health on hard drug use

		OLS	IV
Mental health		0.0002	0.0069
		(0.0007)	(0.0131)
Mental health * Age			
Youth	(≤ 25)	-0.0039***	-0.0043***
		(0.0012)	(0.0009)
Older adults	(≥ 50)	0.0002	-0.0007
		(0.0003)	(0.0020)
Constant		0.0105***	-0.0205
		(0.0030)	(0.0565)
Instrumental variable		No	Yes
Individual fixed effects		Yes	Yes
Wave fixed effects		Yes	Yes
Observations		14,690	11,255

Note. The outcome variable in this table is hard drug use. The young adults category is omitted. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Without the instrument, an increase of 1 point in mental health score is associated with an increase in the probability of hard drug usage of 0.02% for the young adults and an increase of 0.04% for the older adults. For the youth, the probability that someone uses drugs decreases with on average 0.37% if their mental health score increases with 1 point. The estimate of the youth is significant, but all other estimates are not. With the instrument, an increase of 1 point in mental health score is associated with an increase in the probability of hard drug usage of on average 0.69% for the young adults and an increase of 0.62% for the older adults. For the youth, an increase of 1 point in mental health score decreases the probability of hard drug usage of 0.26% on average. The F-statistic of 1489.66 shows the strong first stage of the 2SLS model. Again, only the estimate for the youth is significant.

From the results above, it can be concluded that the found estimates are almost all not trustworthy. This can be because mental health cannot predict the probability of using hard drugs, but given the results in subsection 5.1 and 5.2, that is not the most likely explanation. It is more likely that the number of people that used hard drugs in this dataset is not high enough. Therefore, the estimates are probably imprecise. This means that it is unclear is there is an actual link between mental health and

hard drug usage or if the estimates are driven by random noise in the data. Only the estimate for the youth is significant, so there appears to be an actual link between mental health and hard drug usage for the youth. The percentage of people aged 25 or younger in the sample who used hard drugs is 2.71%, which is a lot higher than the percentages of the other subgroups and the sample as a whole (1.03%), and therefore probably high enough to get significant results. When comparing the OLS and IV results, the instrument again seems to be biased. While the estimates are much smaller than when any drugs and soft drugs were the outcome variables, a constant of 3.03% and a point estimate of 0.84% still seem to be too big, given that only 1.03% of the sample used hard drugs in the month leading up to the survey.

5.4 Hallucinogens

In tables 13, 14 and 15, the effect of mental health on hallucinogen use is presented.

Table 13

The effect of mental health on hallucinogen use

	OLS	IV
Mental health	-0.0007*	-0.0059
	(0.0004)	(0.0058)
Constant	0.0054***	0.0298
	(0.0019)	(0.0277)
Instrumental variable	No	Yes
Individual fixed effects	Yes	Yes
Wave fixed effects	Yes	Yes
Observations	14,692	11,260

Note. The outcome variable in this table is hallucinogen use. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

When estimating the effect of mental health on the probability of using hallucinogens, an increase in mental health score of 1 point is associated with a decrease in the probability of using hallucinogens with on average 0.07% in the absence of an instrument. When the instrument is added to the regression, the average decrease is estimated to be 0.59%. As has been explained in subsection 5.1, the first stage F-statistic is very strong with a value of 161.65. Neither estimates are significant at the 95% level.

Table 14

Sex effects of mental health on hallucinogen use

	OLS	IV
Mental health	-0.0010**	-0.0134
	(0.0005)	(0.0136)
Mental health * Sex		
Male	0.0006	0.0132
	(0.0008)	(0.0136)
Constant	0.0053***	0.0357
	(0.0019)	(0.0340)
Instrumental variable	No	Yes
Individual fixed effects	Yes	Yes
Wave fixed effects	Yes	Yes
Observations	14,692	11,260

Note. The outcome variable in this table is hallucinogen use. The female category is omitted. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

When looking at sex effects in the OLS regression, an increase in mental health score of 1 point decreases the probability of hallucinogen usage with 0.1% for females. For males, a decrease of on average 0.04% is the point estimate. The estimate for females is significant at the 95% level, but the estimate for males is not. For females, a mental health score increase of 1 point is associated with a decrease in hallucinogen usage probability of on average 1.34%, when the IV is added. For males, the estimated decrease is 0.02% on average. The F-statistic of 14852.33 shows that the first stage is very strong. However, these estimates are not significant.

Table 15

Age effects of mental health on hallucinogen use

		OLS	IV
Mental health		-0.0005	-0.0105
		(0.0003)	(0.0066)
Mental health * Age			
Youth	(≤ 25)	-0.0010*	0.0001
		(0.0005)	(0.0005)
Older adults	(≥ 50)	0.0001	0.0017*
		(0.0001)	(0.0010)
Constant		0.0043***	0.0466
		(0.0015)	(0.0284)
Instrumental variable		No	Yes
Individual fixed effects		Yes	Yes
Wave fixed effects		Yes	Yes
Observations		14,690	11,255

Note. The outcome variable in this table is hallucinogen use. The young adults category is omitted. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

In the OLS model, an increase in mental health score of 1 point is associated with average estimated decreases in the probability that someone uses hallucinogens of 0.15%, 0.05% and 0.04% for the youth, young adults and older adults respectively. None of these estimates are significant. In the IV model, the estimated percentages are -1.04%, -1.05% and -0.88% for the youth, young adults and older adults respectively. The F-statistic of 1489.66 shows that the 2SLS first stage is strong. Also in this model, none of the estimates are significant.

In the sample that is used in this research, the number of people that have used hallucinogens is very low. Therefore, similar to the hard drugs estimates, the results in this subsection are likely imprecise. It does not necessarily mean that there is no relationship between mental health and hallucinogen usage, it just means that no causal claims can be made about it in this paper, due to the low power. One exception is the OLS estimate for females, which is significant. It shows that there is a link between mental health and hallucinogen usage for females. When the OLS and IV estimates are compared, the OLS estimate seems to be the most reliable one again. This is visible in the constant and point estimates

of the IV estimations, which seem to be too big for the average percentage of people that used hallucinogens, namely 0.21%.

6. Conclusion and discussion

6.1 Summary and conclusion

In this paper, the effect of mental health on the probability of drug use is researched. Research by Novacek et al. (1991) showed that there might be a link between drug use and mental health, as coping was the second biggest reason for adolescents to start using drugs. Several papers on the association between substance use and mental health found that drug use was associated with poorer mental health (Sullivan et al., 2006; Moore et al., 2007; Schwinn et al., 2010; Van Ours & Williams, 2012), but the direction of the effect is unclear. The first hypothesis is that people with poorer mental health are more likely to use drugs than people with better mental health. Moreover, Schwinn et al. (2010) researched mental health effects on substance use, while making a gender distinction. They did not find gender differences. This leads to the second hypothesis, that the effect of mental health on the probability of drug use is similar for males and females. Lastly, Pearson et al. (2013) found that young people were the most likely to have a mental disorder and/or use substances. This finding is used for hypothesis 3, that the effect of mental health on the probability of drug use decreases with age.

This research takes place in the Netherlands, which is a suitable country for this research, due to its tolerant approach towards drug use. The data comes from the LISS panel, a representative sample of the Dutch population. Within the LISS panel surveys, there are questions about the respondents' mood and substance use in the past month, which are used for the analysis.

To research the effect of mental health on drug use, OLS regression is used. Individual and wave fixed effects are added to increase the probability of finding causal relationships. Moreover, a 2SLS regression is performed to combat reverse causality and endogeneity. To test the second and third hypothesis, a sex and an age interaction effect are added to the OLS and IV regressions. The outcome variables in this research are the probability of using any drugs, soft drugs, hard drugs and hallucinogens.

The first analysis in this research is the effect of mental health on using any drugs. For the whole sample, an increase in mental health score of 1 point decreases the probability of drug use with on average 2.77% without an IV and 14.30% with an IV. For males and females, the estimated decreases are on average 2.25% and 3.15%, respectively in the OLS regression. In the IV regression, the estimated decrease is on average 2.17% for males and 30.36% for females. The high point estimate of 30.36%

and the high constant of 86.50% are indicators that the instrument is biased, despite the strong first stage. For the youth and young adults, the estimated effects in the OLS model are similar (-2.46% and -2.67%, respectively), and the estimated effect for older adults (-2.85%) is significantly stronger. In the IV model, the estimated effect is -16.86% for the youth, -17.76% for young adults and -15.86% for older adults. Again, the point estimates are likely biased. All estimates are significant at the 95% level and show a negative relationship.

In the second analysis, in which the effect of mental health on using soft drugs is researched, the results are very similar. An increase in mental health score of 1 point decreases the probability that someone uses soft drugs with 2.74% on average for the OLS model and with 14.71% on average for the IV model. In the OLS estimation, an increase in mental health score of 1 point, decreases the probability that a female uses drugs with on average 3.12% and decreases the chance that a male uses drugs with on average 2.20%. With the IV added, when mental health score increases with 1 point, the probability of using drugs decreases with 31.29% on average, for females. When looking at the effect of a 1-point increase in mental health on the probability of using drugs for males, it decreases the probability with on average 2.19%. The estimates are significantly different for all age groups, with point estimates of -2.12%, -2.65% and -2.85% for the youth, young adults and older adults respectively, in the OLS model. In the IV model, an increase in mental health score of 1 point decreases the chance that someone uses soft drugs with on average 16.94% if they are 25 years or younger, 18.11% if they are between 25 and 50 years old and 16.01% if they are 50 years or older. Again, all estimates are significant at the 95% significance level. It are again the high point estimates that indicate a biased instrument.

Analysis three measures the effect of mental health on using hard drugs. In the OLS model as well as in the IV model, there are almost no significant estimates. It might be that mental health has no effect on the probability that someone uses hard drugs, but given the highly significant results in the first and second analysis, it is more likely that the estimates are imprecise due to a low percentage of people that used hard drugs in the sample, namely 1.03%. It is for this reason that no causal claims can be made here. The only exception is the estimate for the youth, which is significant, probably due to the relatively high percentage of youth who used hard drugs, which increases the power. When the mental health score of someone aged 25 or younger increases with 1 point, the probability that they use hard drugs decreases with on average 0.37% in the OLS model and with 0.26% in the IV model.

Analysis 4, in which the effect of mental health on hallucinogen use is investigated, also yields mainly insignificant results. Like the hard drugs analysis, the lack of significance in this subsection is likely because not many people in the sample used hallucinogens, namely only 0.21%. Therefore, no causal claims can be made about the effect on mental health on hallucinogen use either. The only significant

result is that for females in the OLS model. In this model, an increase in mental health score of 1 point decreases the probability of hallucinogen usage with 0.1% for females.

Overall, when looking at the significant results, there is a negative relationship between mental health and drug use. This is in line with what was hypothesized. Therefore, the first hypothesis, that people with poorer mental health are more likely to use drugs than people with better mental health, cannot be rejected. These findings are in line with earlier research on the topic, such as the research by Sullivan et al. (2006), Moore at al. (2007), Schwinn et al. (2010) and Van Ours and Williams (2012).

The second hypothesis can be rejected. While it was hypothesized that the effect of mental health on the probability of drug use is similar for males and females, the effect is bigger for females than for males. This can be seen in the significant point estimates, as well as in the small confidence intervals. This finding contradicts research by Schwinn et al. (2010), who found that substance use did not differ by gender. This difference might be because the investigated samples are different. They found that females on average used more drugs than males, while the data in this paper that females on average use less drugs than males. The two studies both find that females have on average poorer mental health than males. It is unclear where the drug use differences come from, as it might be due to a number of things, such as research region or age group. Moreover, Schwinn et al. (2010) researched youth in urban areas, while the research in this paper ha respondents from all kinds of living areas, so villages, small cities, big cities and so on. The differences in results can thus not be explained without further research.

Thirdly, it was hypothesized that the effect of mental health on the probability of drug use decreases with age. When looking at the significant estimates and the confidence intervals, the effect is quite similar for the three age groups. Moreover, when just the point estimates are taken into consideration, the effect of mental health on drug use appears to increase with age, rather than to decrease. Therefore, the third hypothesis can be rejected. Research by Pearson et al. (2013) showed that people aged 15-24 are more likely to have a mental disorder and/or use substances than any other age group. Moreover, they found that the percentage of people with mood and substance use disorders was lower for older age groups. While the descriptive statistics in this paper also show that drug use decreases and that the average mental health score increases with age, what was hypothesized is not in line with the actual results. This might be because Pearson et al. (2013) did not actually research the effect of mental health on drug use, so the hypothesis was not based on similar research but on facts concerning the same topic. This is due to lack on research on the topic.

Lastly, it can be concluded that the instrument in this research is not good enough, despite the high F-statistics of the first stages. This means either of two things. Firstly, the instrument could be correlated

with the error term, causing the independence assumption not to hold. Secondly, the instrument could have a direct effect on the outcome, drug use, causing the exclusion restriction not to hold. The consequence of this is that the IV results are not reliable, so the OLS results are used to draw conclusions. The limitation of that is that reverse causality and simultaneity might still be at play here. However, the IV estimates, though biased, are also negative. Therefore it seems likely that the found negative effect of mental health on drug use is a causal one.

6.2 Internal and external validity

As explained in subsection 4.1, the usage of both individual and wave fixed effects and the use of an IV increase the chance that the significant estimators in this research are causal. The IV does however not seem to improve causality, since it appears to be biased. Therefore, the results from the OLS regression are more reliable. While there is clearly a relationship between mental health and drug use, reverse causality and simultaneity cannot be ruled out due to the lack of a proper IV. The internal validity in this paper is thus not as high as was anticipated.

The paper's external validity is also not very high. The Netherlands has a relatively tolerant approach towards drug use, so in other countries drugs are not as easily accessible. Therefore, in other countries it is more likely that people reach out to other things, such as alcohol, if they suffer from poor mental health.

6.3 Limitations

This paper has some limitations. Firstly, mood is subjective. Therefore, the same feelings of anxiety, peace, depression, happiness and being down might be graded differently by different respondents. However, in this research it might not be that problematic since panel data is used. Therefore, people are compared to themselves rather than to others, so as long as they are consequent in the mental health scores they give, it should not be an issue.

Secondly, mental health is difficult to measure, so mood is used as a proxy. Mood and mental health are not the same though. Still, this is done more often in scientific studies, such as by Van Ours and Williams (2012).

Thirdly, social-desirability bias might be an issue in this paper. There is a negative stigma attached to drug use, so people might not be honest about their drug use in the survey questions. Given that the stigma about using soft drugs is not as negatively loaded in the Netherlands, this issue is probably the biggest in the hard drugs and hallucinogens estimations. This bias cannot be tested or corrected for, which is why it is a limitation of the research.

Fourth, the instrument that is used in this research turns out not to be as good as was expected. Therefore, reverse causality and endogeneity cannot be ruled out.

Lastly, there is recent literature that criticizes the use of two-way fixed effects models, in some situations (De Chaisemartin & d'Haultfoeuille, 2020). It is argued that the use of negative weights is problematic when the treatment effect is heterogeneous between groups or over time. It can create a situation in which the estimated treatment effect is negative, while the actual treatment effect is positive in every group and in every time period. It is important to acknowledge the possible limitation of the chosen method in this research, especially since there has not been adjusted for this limitation.

6.4 Recommendations

From this paper can be concluded that there is a negative relationship between mental health and drug use. Additionally, poorer mental health might increase drug use. The effect size is bigger for females than for males. One possible way to tackle part of the drug use in the Netherlands, is by helping people who suffer from mental health issues. However, the estimated effects are small so this might only solve a small part of the problem. Moreover, this paper is proof that poor mental health can be a reason for people to engage in bad behavior, which is another reason why it is so important to ensure that people have good mental health and/or access to good mental health care.

In terms of further research, there are some interesting things yet to be investigated. Firstly, this paper found mainly insignificant estimators of the effect of mental health on the probability of using hard drugs or hallucinogens. This is probably due to the low number of people in this sample who stated that they used these kinds of drugs. In future research, it is interesting to investigate this further, but with a bigger sample to increase the power. Secondly, it is interesting to investigate the effects of mental health on drug use in countries that have a less tolerant drug use approach. It is important to note though, that the social-desirability bias might be higher in such countries, so those results might be more biased than the ones in this research. Thirdly, it might be useful to investigate if different results are found when, instead of mood, actual mental health will be used. For example, investigating the effect of certain disorders on drug use or by measuring mental health with an official mental health questionnaire. Lastly, if a good instrument is found, it is interesting to redo this research and see how it affects the IV estimates.

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