

The Association Between Substance Use and Loneliness in Adolescence



Guusje M. Roessink (5891701)

Dr. Marlies Maes

Master Youth Studies

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Abstract

In adolescence, substance use is quite prevalent. Substance use brings a heightened risk for mental and physical health problems, therefore it is crucial to understand what factors associate with substance use in order to improve substance use interventions. One factor that has shown to be associated with substance use is loneliness. Previous research on this association mostly focused on adults. Therefore, this thesis aimed to examine if there is an association between loneliness and substance use in adolescence, by using data from the MASLO-project. The associations ($N = 31$) between loneliness and substance use were investigated with a random-effects meta-analysis. The results of this analysis showed no significant relationship between loneliness and substance use ($p = .265$). In addition to the direct association between loneliness and substance use, the moderating factors *age*, *sex* and *type of substance use* were examined. These results showed no significant effect of the moderators on the association between substance use and loneliness. This study shows that although loneliness and substance use are both common in adolescence, no association is found between the two variables, which indicates that these are separate occurrences during adolescence and they are not significantly related to each other.

Keywords: loneliness, substance use, adolescents, emerging adults

Samenvatting

Middelengebruik komt veel voor in de adolescentie. Er is een verhoogd risico op mentale en psychische gezondheidsproblemen bij het gebruik van middelen, daarom is het belangrijk om te begrijpen welke factoren associeren met middelengebruik om zo interventies van middelengebruik te verbeteren. Bestaande literatuur over dit onderwerp focust zich vooral op volwassenen. Daarom had deze thesis als doel te onderzoeken of er een associatie is tussen eenzaamheid en middelengebruik in adolescenten, met gebruik van data uit het MASLO-project ($N = 31$). De associaties tussen eenzaamheid en middelengebruik zijn onderzocht met een random-effects meta-analyse. De resultaten van deze analyse waren niet significant, wat betekent dat er in deze data geen relatie is tussen middelengebruik en eenzaamheid ($p = .265$). Daarnaast zijn de moderatoren leeftijd, sekse en type middelengebruik onderzocht, ter toevoeging aan de directe associatie tussen middelengebruik en eenzaamheid. De moderatoren hadden geen significant effect op de associatie tussen middelengebruik en eenzaamheid. Deze studie laat zien dat hoewel eenzaamheid en middelengebruik allebei veel voorkomen in adolescentie, er geen associatie is tussen de twee variabelen. Dit impliceert dat dit twee verschillende gebeurtenissen zijn tijdens de adolescentie en dat ze niet significant gerelateerd zijn aan elkaar.

Kernwoorden: eenzaamheid, middelengebruik, adolescenten, jongvolwassenen

The Association Between Loneliness and Substance Use in Adolescence

Adolescence is a period of life where risk behavior is particularly prevalent (Moffitt, 1993). One of these risk behaviors is substance use. Substance use is defined as using substances for an intended purpose, this can be legal or illegal (Marshall & Spencer, 2018). Among 12 to 16 year old adolescents, 26% drink alcohol, 7% smoke and 10% have used cannabis (De Staat van Volksgezondheid en Zorg, 2020), and those numbers go up as adolescents grow older. Adolescent risk behavior is related to neurological factors, like underdeveloped inhibition (Peper & Dahl, 2013), and social factors, such as the increased susceptibility to peer influences on decision-making among this age group (Gardner & Steinberg, 2005; Knoll et al., 2015).

Substance use can be detrimental for adolescents' well-being and development, as it is related to mental and physical health problems (Schulte & Hser, 2014). An underresearched factor that seems to be related to substance use is loneliness (Ingram et al., 2020; Pengpid & Peltzer, 2017). Loneliness is defined as the negative emotional response to a discrepancy between the desired and the achieved quality and quantity of one's social network (Vanhalst et al., 2014). People who experience loneliness can have psychological problems, like depression, and physical health problems, such as poor sleep quality (Hawkey & Capitanio, 2015; Heinrich & Gullone, 2006).

Adolescents are particularly susceptible to feeling lonely (Qualter et al., 2013), with 80% of adolescents experiencing loneliness (Berguno et al., 2004). This susceptibility could be due to the rapid social development during adolescence, with an increased need to belong (Knoll et al., 2015). However, most of the research and interventions on substance use, have not focussed on loneliness as an associating factor. The existing literature on the association between substance use and loneliness predominantly focuses on adults and people who have substance use problems (Ingram et al., 2020). Therefore, this study aims to look at adolescents for the association between substance use and loneliness.

The Association Between Substance Use and Loneliness

There are multiple theoretical ideas that could explain the association between substance use and loneliness. Firstly, the self-medication theory of Khantzian (1997) could be an explanation for this association. The self-medication theory states that people start using substances as a self-medication mechanism to deal with physical or psychological problems (Bolton et al., 2009; Khantzian, 1997), like depression (Hammig, 2019). Therefore, it could be that lonely adolescents seek substances to self-medicate their feelings of loneliness.

Secondly, because adolescents have an increased susceptibility to peer influences

(Steinberg & Monahan, 2007; Van Hoorn et al., 2016) and have a strong need to belong (Knoll et al., 2015), they could develop high expectations regarding social relationships. These increased expectations may be hard to reach, which causes a discrepancy between their desired social life, and their actual social life. This discrepancy can cause feelings of loneliness. Moreover, research shows that adolescents who are popular have increased prevalence of substance use (Tucker et al., 2011), and adolescents who believe their popularity increases by substance use, are more likely to start using substances in an attempt to be liked by peers (Trucco et al., 2011; Tucker et al., 2011). Therefore, loneliness could be associated with substance use in adolescents who are lonely and want to belong.

Lastly, a negative association between substance use and loneliness is also possible. When adolescents start using substances, they often hope to be liked by peers, because deviant behavior is attractive to peers (Moffit, 1993). This could mean that adolescents who use substances, are more liked by peers and have increased popularity (Trucco et al., 2011; Tucker et al., 2011). In turn, their high social expectations (Knoll et al., 2015) are met which could make them feel less lonely.

Empirical evidence for the association between substance use and loneliness

There is already some empirical evidence for the association between substance use and loneliness, but the research that focuses on this association conveys mixed results. Some studies found positive associations between substance use and loneliness. For example, the systematic review by Ingram et al. (2020) suggests that people with substance use problems scored higher on loneliness scales. Vice versa, in a longitudinal study, McKay et al. (2017) found that loneliness at first measure had an impact on alcohol use 12 months later. An increase of loneliness with an increase of substance use was also found in a recent cross-sectional study on adolescents (Kayaoglu et al., 2021). Furthermore, it was found that smokers suffered from higher rates of psychological problems, including loneliness (Habibi et al., 2018; Zhang et al., 2020). This positive association with loneliness was also found for drug users, who were more likely to score high on the loneliness scale compared to non-drug users (Rokach, 2002).

Contradicting these results, multiple other studies found that there was no significant association between loneliness and substance use. For example, in the systematic review of Dyal and Valente (2015) they reviewed studies on the association between smoking and loneliness in adolescents, and only half of the studies reported a significant association between loneliness and smoking. Nevertheless, all but one of those studies found a positive association between loneliness and smoking. Moreover, Pandya (2017) found that male

cannabis users between 20-25 years old, did not differ significantly from non-cannabis users in feelings of loneliness.

Concluding, there are mixed results found for the association between loneliness and substance use, but when there is an association, it is mostly a positive association instead of a negative association.

Moderating Factors

The association between loneliness and substance use could depend on moderating factors, namely age, sex and type of substance use.

Age Differences

Adolescence is a broad age group (12-24) with a lot of differences between younger adolescents (12-18) and older adolescents (18-24). For example, in most countries, older adolescents are legally allowed to drink. In the Netherlands, 86% of 18-25 year-olds drink alcohol regularly, 20% has used cannabis and 20% of the population is a smoker (CBS, 2018). This behavior is seen as normative for older adolescents, but not for younger adolescents. It could be that older adolescents are more often already users of substances like alcohol and smoking, which makes them more prone to use substances when they feel lonely (Hämmig, 2019). Therefore, it is important to look at the age differences in the association between substance use and loneliness.

Most of the research on the association between loneliness and substance use focuses on adolescents above 18 (Habibi et al., 2018; Pandya, 2017; Zhang et al., 2020). In these studies mostly positive associations were found between loneliness and substance use. However, there were multiple studies that did not find an association between substance use and loneliness in older adolescents (Dyal & Valente, 2015). A systematic review by Ingram et al. (2020) showed that in most studies younger people who used substances reported more loneliness than older people. Multiple studies found significant results for the association between substance use and loneliness in younger adolescents (Malta et al., 2014; Page et al., 2011).

From the literature, we can conclude that it could be that older adolescents are more exposed to substances in general. However, younger adolescents experience stronger associations between loneliness and substance use. This could be a result of the fact that they are adolescents who engage in deviant behavior (Moffit, 1993), because they have to illegally access the substances, whereas emerging adults have easy access to the substances. Deviant adolescent behavior may stem from an uninvolved parenting style, which can also cause psychological issues like loneliness (Hoskins, 2014). Furthermore, it could also be that the

younger adolescents have a stronger increased need to belong (Knoll et al., 2015) than the older adolescents. This need to belong decreases with age. The need to belong in younger adolescents could lead to a discrepancy in their social expectations, which can make them engage in substance use, in an attempt to be liked by peers (Trucco et al., 2011).

Concluding, there are differences in the association between substance use and loneliness between younger and older adolescents, but the association seems stronger for younger adolescents.

Sex Differences

Adolescent substance use is driven by different processes for boys and for girls (Toray et al., 1991). As is known from research, adolescent deviant behavior, such as substance use, is more common in boys (Moffit, 1993). However, although internalising problems, like loneliness, are more common in girls (Hammig, 2019), boys tend to cope with these feelings more in avoidance strategies (Sigmon, Stanton, & Synder, 1995), and drugs or alcohol use (Carver et al., 1989; Kieffer, Cronin, & Gawet, 2006). Therefore, the self-medication theory (Khantzian, 1997), could be stronger for boys than for girls, which could make boys more prone to use substances to cope with negative feelings of loneliness.

Previous research found mixed results for sex differences in the association between loneliness and substance use in adolescence. Multiple studies did not find clear sex differences in the association between loneliness and substance use (Dyal and Valente, 2015; Habibi et al., 2018; Zhang et al., 2020). However, in a study done in Russia and the US (Stickley et al., 2014), loneliness in boys was associated with an increase in marijuana, smoking and other illicit drug use, whereas lonely girls were associated with alcohol and binge drinking. Nevertheless, multiple studies show stronger associations for women between loneliness and substance use (Ingram et al., 2020), and specifically loneliness and alcohol use (Mannes et al., 2016; McKay et al., 2017).

Concluding, although from theory it is expected that the association between loneliness and substance use is higher in males, most research shows evidence for a stronger association in females. Therefore, adding the moderator sex will clarify the difference between males and females in the association between substance use and loneliness.

Type of Substance Use

Loneliness may be differently associated with different types of substance use. The conventionality of the types of substances differs, as alcohol and smoking are legal and widely accepted in society. Drugs, however, are mostly illegal and less common (Bauman & Phongsavan, 1999). Therefore, it is expected that if adolescents use substances, they are

generally more often users of alcohol and tobacco. For self-medication of loneliness (Khantzian, 1997), the accessibility of alcohol and tobacco could be a reason to use these substances over drugs to self-medicate loneliness.

In several studies tobacco and alcohol showed similar associations as cannabis use with psychological outcomes (Macleod et al., 2004). Furthermore, an association between loneliness and smoking was found in multiple studies (Dyal and Valente, 2015; Lauder et al., 2006; Malta et al., 2014; Wootton et al., 2020). Contradictingly, a longitudinal study among younger adolescents found that loneliness throughout the ages of 7-17 years predicted more units of alcohol consumed per drinking occasion at age 17, but no effects on smoking or drug use (Qualter et al., 2013). Furthermore, one study found that lonely people reported less cannabis use (Grunbaum et al., 2000), which shows a negative association for drug use.

Previous research mostly focuses on the association between loneliness and alcohol, smoking or drug use specifically, which makes it difficult to compare the different types of substances to each other. Therefore, it is important to investigate these different types of substance use in their association with loneliness in one analysis.

Current Study

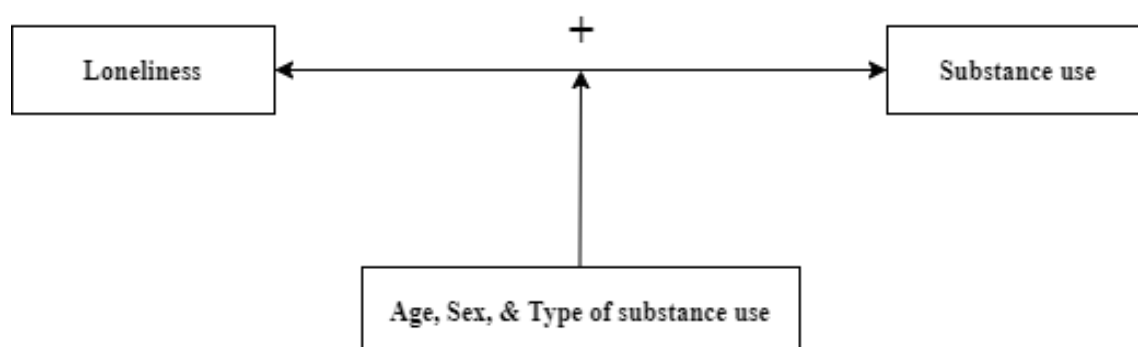
The association between loneliness and substance use have been examined in the past, but no consensus is found in the literature. Moreover, the association between specifically loneliness and substance use has been investigated with systematic reviews (Dyal & Valente, 2015; Ingram et al., 2020), however, these studies do not specifically look at adolescents. Dyal and Valente (2015) only looked at the association between loneliness and smoking, and no other types of substances. Ingram et al. (2020) only included studies with participants who had substance use problems. Thus, the results of existing systematic reviews are not applicable to adolescents who occasionally use substances. Therefore, this thesis aims to examine if there is an association between loneliness and substance use in the adolescence age group, by using a meta-analytical dataset. We expect that there is a positive association between loneliness and substance use in adolescents (H1).

In addition to the direct association between loneliness and substance use, the moderating factors *age*, *sex* and *type of substance use* will be added to the association between loneliness and substance use. For the moderator *age*, we expect that the association between loneliness and substance use in adolescents is stronger for younger adolescents (12-18) in comparison to older adolescents (18-24) (H2). Secondly, we expect that the association between loneliness and substance use in adolescents is stronger for females than for males (H3). Lastly, we expect that the association between loneliness and substance use in

adolescents is different for types of substances (alcohol, tobacco and cannabis), with a positive association between loneliness and alcohol and tobacco use, and no association between loneliness and drug use (H4).

Figure 1

Research Model with the Variables Loneliness, Substance use, Sex, Age and Type of Substance.



Methods

Literature Search

This study uses the meta-analytical dataset from the MASLO project (Meta-Analytical Study of Loneliness) (Maes et al., 2019). MASLO is an extensive database with a large scope of data from over 60 countries. All studies have assessed loneliness with a standardized questionnaire. The database was created by conducting literature searches in Psycinfo, ERIC, PubMed, and Web of Science. The details of the literature search can be found in Maes et al. (2019). The list of key terms used for the literature search can be found at the Open Science Framework (<https://osf.io/tzg32/>). The total amount of studies in the MASLO database was 3,500 in the 2016 data search. All reports were coded using a coding protocol. The coding was done by a team of trained students with guidance of a coding manual.

Selection of Studies

For the current study we selected associations between loneliness and substance use from the dataset by filtering for the code representing substance use (58 associations). All other associations with different codes were checked for relevancy, but no additional studies were found. Secondly, studies were selected that included analyses of group differences related to substance use (1 study with 5 samples). Next, because the current study focuses on the age range 12-24, we selected studies that included the adolescent (12-17.9) and emerging adult (18-24.9) age categories. 17 studies that included associations remained, and one study

that looked at group differences remained (5 samples). The studies that included the association between loneliness and substance use in other age categories were removed (8 studies). Furthermore, we searched the new database of 2020 if this included studies with associations between loneliness and substance use and looked at the age group of 12-25. This resulted in the addition of 4 studies. In total, 32 associations (k) from 22 samples remained.

Study Coding

The final dataset consisted of written reports ($N = 22$) published between 1987 and 2018. Countries where the data was collected are the United States ($N = 12$), United Kingdom ($N = 2$), Canada, Turkey, Hungary, Ukraine, China, Thailand, Hong Kong and the Philippines ($N = 1$ for each study). Sample sizes ranged from 90 to 3,320 with a mean sample size of 248.5. The mean age of the samples was 18.2 years ($SD = 2.03$), with a range of 14.9 to 21.1 years. 39.6% of the participants were male.

Age

In this study, the samples that included the age categories “adolescents” (12 - 17.9) and “emerging adults” (18 - 24.9) were selected. If the age range for a sample spanned more than one category, the category that corresponded with the mean age was chosen. For the moderator *age*, we kept the division of these two categories to examine the effect of age on the meta-analysis. This resulted in $k = 10$ for the adolescents category, and $k = 22$ for the emerging adults category.

Sex

To examine whether there are sex differences in the association between loneliness and substance use, we looked at the percentages of males (39.6%) and the effect that code had on the meta-analysis.

Type of Substance Use

We categorized substance use into three categories: alcohol ($k = 16$), smoking ($k = 8$) and drug use ($k = 7$). This comes to a total of $k = 31$. One association could not be categorized into the three categories, because that sample looked at substance use in general.

Effect Size Calculations

The MASLO dataset includes the values of the correlations. These correlations between loneliness and substance use were converted to *Fisher's z*. *Fisher's z* is computed with the following formula: $z = 0,5 \times \ln\left(\frac{1+r}{1-r}\right)$. The variance of z is the following: $V_z = \frac{1}{n-3}$, with the standard error (SE) of this variance being $SE_z = \sqrt{V_z}$. The standard error is used to

weigh the different studies. After the analysis, the transformed variables of the main association were converted back to correlations for presentation.

Statistical Analysis of Effect Sizes

Firstly, the effect sizes were used for the analysis of the association between loneliness and substance use. The analysis is done by using the data-processing program JASP (JASP Team, 2020). With JASP, the association was researched by using a meta-analysis, with a random-effects analysis, to test an overall relationship between loneliness and substance use.

Secondly, moderator variables *age*, *sex* and *type of substance use* were added to the model. Moderators are used to test which factors can explain variability in effect sizes. They were added to the meta-analysis separately.

Lastly, to test if there is a potential impact of publication bias, a funnel plot was analysed. Testing for publication bias is important in meta-analysis, because studies with non-significant results, are sometimes less likely to be published. Therefore, the results of meta-analyses could be biased as well. The funnel plot can show equal distribution of the effect sizes. Egger's linear regression method was used to test whether there is a significant relation between the effect sizes and the sample size of the studies. A significant relation can indicate publication bias, because that means there is an unequal distribution of studies.

Furthermore, analyses and results in JASP were captured by screenshotting the steps of the JASP data-analysis, to ensure the transparency of the research.

Results

The Association Between Loneliness and Substance Use

Using the mean effect size and standard error, we conducted a random-effects analysis. For the overall association between loneliness and substance use, we did not find a significant effect, with $r = 0.04$, ($SE = 0.02$, $p = .114$, and 95% $CI [-0.009, 0.083]$). The results indicate that within this dataset, there is no relation between loneliness and substance use in adolescents and emerging adults.

The results further showed a significant residual heterogeneity ($Q = 112.725$, $p < .001$), which indicates heterogeneity among the effect sizes. The heterogeneity is further supported by the I^2 statistic of 83%, which indicates a high level of heterogeneity. There was one influential outlier in the dataset, with a standardised residual of 3.881. Therefore, we removed this outlier from the dataset, which resulted in $k = 31$. This changed the outcomes of the random-effects analysis, with $r = 0.02$, ($SE = 0.02$, $p = .265$, and 95% $CI [-0.016, 0.060]$).

Moderators of the Association Between Loneliness and Substance Use

To test if the hypothesized moderating factors had an effect on the association between loneliness and substance use, we added three moderating factors to the random-effects analysis without the outlier (Table 1). The moderators were added separately from one another to the meta-analysis.

First, we added the moderator *age* to the random-effects analysis ($k = 31$). This moderator had two categories, adolescents and emerging adults. The results of the analysis showed that age did not have a significant effect on the association between loneliness and substance use ($Q = 0.036, p = .849$) (Table 1).

Next, the moderator *sex* was added to the model separately ($k = 31$). This moderator was added to test whether there was an effect of sex on the association between loneliness and substance use. The moderation of sex on the association between loneliness and substance use showed insignificant results ($Q = 2.927, p = .087$) (Table 1).

Lastly, we added the moderator *type of substance use* ($k = 30$). This moderator had three categories: alcohol, smoking and drug use. Overall, the analysis showed that this moderator was not significant ($Q = 3.733, p = .155$) (Table 1).

Table 1

Coefficients Table of the Moderators Age, Sex and Type of Substance Use Added to the Random-effects Model of the Association Between Loneliness and Substance Use.

	<i>B</i>	<i>SE (B)</i>	<i>p</i>	95% CI	
				Lower	Upper
Age					
intercept	0.028	0.036	0.434	-0.042	0.098
Emerging Adults	-0.008	0.043	0.849	-0.092	0.076
Sex					
intercept	0.113	0.057	0.047	0.002	0.225
Male	-0.238	0.139	0.087	-0.511	0.035
Type of Substance Use					
		0.155			
intercept	0.046	0.025	0.066	-0.003	0.095
Smoking	-0.080	0.045	0.076	-0.169	0.008
Drugs	-0.056	0.043	0.197	-0.141	0.029

Note. Moderators were added to the model separately, but placed into one table for readability purposes.

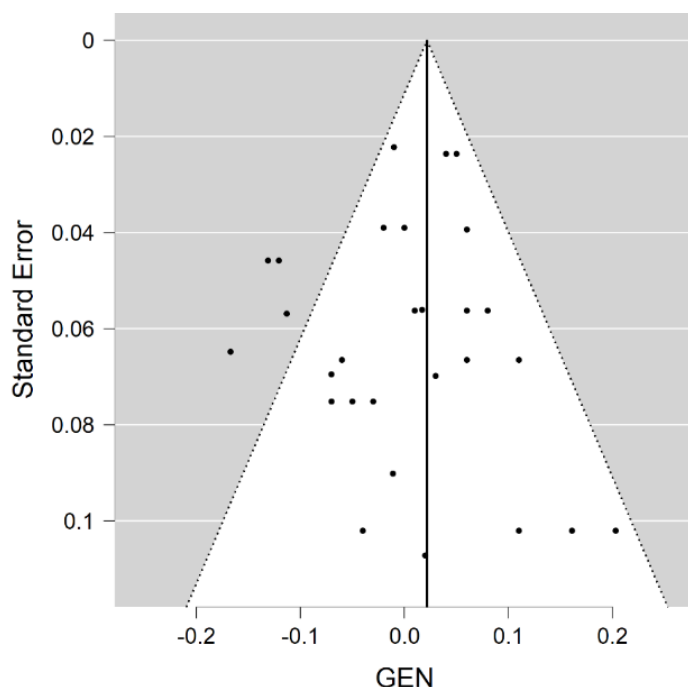
^aReference categories (intercept) were: adolescents (age), females (sex), and alcohol (type of substance use).

Publication Bias

We examined the presence of publication bias by creating a funnel plot (Figure 2). The plot effectively formed a kind of funnel shape. The funnel plot seems to show an equal distribution of studies, which suggests that there is probably an absence of publication bias. To test for publication bias statistically, we applied the Egger's regression test, which was significant ($z = 2.320$, $p = .020$). Significance suggests publication bias, which makes it probable that publication bias could have an effect on the outcomes of this study. Nevertheless, the model seems symmetrical, so the influence of publication bias is therefore ambiguous and expectedly not large.

Figure 2

Funnel Plot Including a Regression Test for Funnel Plot Asymmetry (Egger's Test).



Note. Standard errors are plotted on the y-axis, the observed effect sizes on the x-axis.

Discussion

Substance use is prevalent in adolescence, with detrimental effects for adolescent mental and physical health (Schulte & Hser, 2014). Previous research showed that loneliness could be a factor that is associated with substance use (Ingram et al., 2020; Pengpid & Peltzer, 2017). However, research on this association is scarce. Therefore, the present study investigated whether there is an association between loneliness and substance use in adolescents (12-24). This analysis showed no significant effects for this association. When including the moderators *age*, *sex*, and *type of substance use*, the association varied somewhat, but not significantly.

The Association Between Loneliness and Substance Use

Previous literature shows inconsistency in finding an association between loneliness and substance use in adolescents. The empirical literature that did find an association between loneliness and substance use in adolescents, found mostly positive associations, which means that loneliness increases when substances are used, or vice versa (Ingram et al., 2020; Dyal & Valente, 2015; Habibi et al., 2018; Zhang et al., 2020).

Firstly, we expected an association based on the self-medication theory (Khantzian, 1997). Loneliness showed to be related to self-medication in the form of substance use (Hämmig, 2019). However, evidence for the self-medication theory was not found in this study. This could mean that data did not include people who experienced loneliness to such an extent that they needed to self-medicate. However, adolescents could also lean towards other coping mechanisms instead of substance use to deal with their feelings of loneliness.

Secondly, we expected an association between substance use and loneliness, based on the heightened susceptibility to peer influences (Steinberg & Monahan, 2007; Van Hoorn et al., 2016) and need to belong (Knoll et al., 2015) in adolescence. It could be that the discrepancy between adolescents' desired social life and their actual social life is not large enough to feel lonely, or not large enough to feel that they have to use substances to belong or be popular among peers.

Moderators

After the meta-analysis of the association between loneliness and substance use, we added the moderators *age*, *sex*, and *type of substance use* to see if these moderators positively or negatively influenced the association.

The moderator *age* was not significant, which we did not expect (H2), as the literature showed that younger adolescents seem to have a stronger positive association between loneliness and substance use than older adolescents (Ingram et al., 2020). We expected it to be

stronger for younger adolescents, because substance use is illegal for them, and this illegality causes substance use to be more common in deviant adolescents (Moffit, 1993). These deviant adolescents often have uninvolved parents (Hoskins, 2014), which is shown to relate to psychological issues like loneliness. However, because these deviant adolescents are not normative, they would not have a strong influence in the dataset. Thus, if this theory was true, the analysis could still be insignificant.

Secondly, the moderator *sex* was not significant, which was not expected (H3). The literature showed that adolescent substance use is driven by processes that are different for sexes (Toray et al., 1991), and males and females differ in the association between loneliness and substance use (Stickley et al., 2014), as females often show stronger associations between substance use and loneliness (Ingram et al., 2020; McKay et al., 2017). Nevertheless, the fact that no significant differences were found, shows that sex does not change the association between loneliness and substance use. Literature showed that the stronger association for females was mostly for alcohol use and loneliness (McKay et al., 2017; Stickley et al., 2014). Therefore, it could be that the association for substance use in general was not that strong, because the analysis also included smoking and drug use.

No significant differences were found for the moderator *type of substance use*, which was not what we hypothesized (H4) based on the literature. We expected to find a stronger association for alcohol and smoking, compared to drug use. However, the insignificant results are not strange, because literature showed mixed results when looking at the different types of substance use and their association with loneliness (Grunbaum et al., 2000; Habibi et al., 2018; Pandya, 2017; Qualter et al., 2013). Related to the self-medication theory (Khantzian, 1997), you would think that lonely adolescents are prone to start drinking or smoking to self-medicate their feelings, because they are used to these substances as they are normative (CBS, 2018). However, because the literature shows mixed results, this hypothesis was not that strong, so the results match the inconsistent literature on this topic.

Strengths and Limitations

The current study had multiple strengths. First, as a meta-analysis, this study gives a summarization of data on the topic of substance use and loneliness. Therefore, conclusions of this meta-analysis can give stronger claims about this association, compared to cross-sectional research. Secondly, by including all types of substance use, we could compare the different types of substance use in their association with loneliness with the same data.

This study also had limitations. Firstly, samples were categorized into age groups when they were coded, of these age groups we used two categories (adolescents and emerging

adults). These categories were made by using the mean age of the samples. However, in the dataset of the current study, some samples were not age-homogeneous. For example, one sample included 17 to 48 year olds, but was categorized in the emerging adult category. Thus, this sample could be non-representative for the population of emerging adults, because it also includes older adults.

Secondly, it could be possible that the dataset of MASLO does not include all studies on this topic. Maybe searching in additional databases could have led to additional findings on loneliness and substance use in adolescents or not focussing on the loneliness measures when searching the databases could result in more studies with other loneliness scales.

Thirdly, there was a significant Egger's test which could mean that there was publication bias in the sample. This could mean that the selected studies from the database are not representative for all the studies done on this topic. Researchers should publish all results, because it shows a more realistic image of the research that is already done.

Lastly, because there was a lack of associations for this meta-analysis, we included associations that measured any association between alcohol and loneliness, smoking and loneliness, and drugs and loneliness. This meant that some associations did not measure alcohol, smoking and drug use in the same way. For example, frequency of use, quantity of use or being a current drinker were all put in the same category for alcohol use, also if they came from the same sample. This category of alcohol use is therefore not homogeneous in what association it actually portrays, because the association between frequency of alcohol use and loneliness, and the association between quantity of alcohol use and loneliness can be completely different.

Recommendations for Future Research and Practical Implications

After reviewing the theoretical and empirical literature on loneliness and substance use in adolescents and emerging adults, we have some recommendations for future research. Generally, there are not that many studies done on the association between loneliness and substance use. Barely any theoretical contentions are available on this topic. Furthermore, when selecting studies from the database of over 3,000 loneliness studies, less than 100 remained. Even less studies remained when we selected for the age categories adolescents, which suggests that the empirical literature on loneliness and substance use is scarce among this age group. Extensive research could give more consensus on the association between loneliness and substance use and the existence of this association in adolescence.

In addition, there should be an aim on research outside western countries, like South-America and Africa. From the MASLO database, it became clear that most of the research is

done in western countries. This data could not be representative for the countries that are not included in the samples, because of cultural or societal differences. Including these countries could lead to different results. Additionally, research should always be representative and applicable to different cultures, ethnicities and socio-economic statuses. Including all continents in research creates a less generalized Western view on the way adolescents and emerging adults experience loneliness and substance use.

A practical implication for researchers, policy makers, and other professionals is that even though both loneliness and substance use are common in adolescence and can have detrimental effects on a positive and healthy development (Marshall & Spencer, 2018; Heinrich & Gullone, 2006), there is no association between substance use and loneliness. Practitioners should not focus on loneliness in substance use interventions, or focus on substance use in loneliness interventions, as this association probably does not exist for most adolescents.

Conclusion

To conclude, this meta-analysis on the association between loneliness and substance use in adolescents showed that there is no significant association between the two common phenomena in this age group. Overall, there are no signs that loneliness and substance use are connected, even when looking at age differences, sex differences, and different types of substance use. Further research is necessary to achieve theoretical consensus on the association of this meta-analysis.

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