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Substance addictions and suicidal thoughts and behaviors: Evidence from a multi-wave epidemiological study

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ABSTRACT

Substance addiction (SA) is a risk factor of suicidal thoughts and behaviors (STB), although it is still unclear which SAs are reliably associated with increased risk for suicidal ideation, planning, and attempt. The current study aimed to meet this goal using data from the National Survey on Drug Use and Health (NSDUH) referring to years from 2008 to 2020. The information extracted included sociodemographic and contextual information, eleven SAs (e.g., nicotine, alcohol, marijuana, cocaine, pain relievers, heroin, inhalants, hallucinogens, sedatives, stimulants, and tranquillizers), and STB. The analysis revealed that SAs for alcohol, pain relievers, marijuana, and cocaine were stable and reliable predictors for STB (e.g., suicidal ideation, planning, and attempt), while cocaine was not a stable predictor for suicide attempt. The selected SAs model showed a greater predictive accuracy than only sociodemographic and contextual factors as well as not selected SAs. Moreover, selected SAs showed comparable predictive accuracy to the full model. Furthermore, SA to alcohol showed to be an extremely effective predictor of STB, having a comparable predictive accuracy to all the other ten SAs together. In conclusion, SAs to pain relievers, alcohol, marijuana, and cocaine can be considered as important risk factors for concurrent STB.

1. Introduction

Substance addiction (SA) is a complex and multifaceted condition that involves problematic use of psychoactive substances, such as alcohol, drugs, and prescription medications. SA is characterized by a range of cognitive, behavioral, and physiological symptoms, which include impaired control, continued use despite negative consequences, and a high risk of relapse. Over time, SA can lead to tolerance, dependence, and withdrawal symptoms, which can further perpetuate the cycle of drug use (American Psychiatric Association, 2013). In the United States (US) in 2019, approximately 20.4 million people aged twelve or older had a SA, comprising 14.5 million with alcohol addiction and 5.9 million with other SAs (National Survey on Drug Use and Health, 2020). In the same year, alcohol addiction was responsible for 345 Disability-Adjusted Life Years (DALYs) per 100,000 individuals, while addiction to other substances accounted for 2,019 DALYs per 100,000 individuals in the US (Institute for Health Metrics and Evaluation, 2020; World Health Organization, 2020). Moreover, in 2021, almost 110,000 deaths in the US were alcohol-related, and the number of overdose deaths peaked at almost 107,000 (Centers for Disease Control and Prevention, 2023).

Solid evidence shows that one of the most severe consequences of SA is increased risk of suicidal thoughts and attempts, otherwise known as suicidal thoughts and behaviors (STB), as well as completed suicides (Armoon et al., 2021; Lynch et al., 2020; Poorolajal et al., 2016). While the association between SAs and STB has been broadly investigated, the majority of the studies have mostly focused on single substances. For example, alcohol addiction was linked to suicidal ideation and attempt as well as to completed suicide (see meta-analysis by Darvishi et al., 2015), while cannabis addiction was related to an increased risk of suicidal ideation (Borges et al., 2016; Sellers et al., 2019). Opioid addiction and polydrug use were associated to suicidal ideation in inpatients (Andersson et al., 2022), with daily use of cocaine and benzodiazepines (regardless of whether they were prescribed or not) being significantly associated with suicide attempts (Jangal et al., 2022). Furthermore, a few meta-analyses considered addiction to restricted sets of substances in relation to STB. For instance, Poorolajal and collaborators (2016) reported a positive relation between SA and suicidal ideation and attempt, considering studies about marijuana, cocaine, and opioids. More recently, another meta-analysis confirmed a positive

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relationship between addiction to nicotine, alcohol, and cannabis and suicidal ideation and attempt (Armoon et al., 2021). Finally, Breet and colleagues (2018) reported a positive association between abuse or addiction to nicotine, alcohol, cannabis, opioids, sedatives, and inhalants, and STB in low- and middle-income countries.

Despite extensive research, a systematic investigation considering simultaneously how different addictions to major classes of substances are linked to distinct STB – suicidal ideation, planning, and attempts – has not yet been conducted. In order to achieve a more comprehensive understanding, it is important to encompass all types of substances, namely legal (i.e., tobacco, alcohol, etc.) and illegal (i.e., heroin, cocaine, etc.), as well as psychotherapeutic substances used for non-medical purposes (i.e., pain relievers, stimulants, etc.). To meet this goal, we relied on large cross-sectional, multi-wave, epidemiological datasets derived from the National Survey on Drug Use and Health (NSDUH), which represents one of the most important sources of information for the study of substance addictions and mental health in the US to date.

2. Method

2.1. Subjects

The current study was based on a large, multi-wave epidemiological cross-sectional study from 2008 to 2020, with sample size ranging from ~25.800 to ~42.800 observations. Only participants aged 18 years or older were included, given that younger participants were not routinely asked about STB. Each dataset comprised adult individuals, ranging from 18 to 65 years old or more, roughly equal by gender (i.e., 46.4 % male).

NSDUH is a large epidemiological study that annually recruits a representative sample of US individuals. The sampling was conducted in all 50 states and the District of Columbia (U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality, 2010). Each state was divided in regions with roughly the same number of inhabitants, and households were selected based on a multi-step statistical strategy. An adult from each household was then briefly interviewed, in order to assess general information. If the criteria were met, one or two individuals were selected for the survey. The survey lasted circa one hour and was administered both via computer and in-person. The answers were treated as confidential, and $30 were given to each participant. NSDUH datasets have served as the foundation for significant and influential studies in the field of addiction and suicidality (e.g., Han et al., 2017; Twenge et al., 2019).

2.2. Measures

2.2.1. Sociodemographic and contextual information

Gender, age, race, education, income, general health, and the number of times the person moved in the past year were considered sociodemographic and contextual variables (for more information, see Table S1). Moving was taken into consideration as a contextual variable because frequent residential change is a potentially stressful event that can have a negative impact on a person's well-being (Oishi, 2010).

2.2.2. Substance addictions

We extracted information on self-reported addiction to eleven substances in the past year, namely nicotine, alcohol, cocaine, heroin, pain relievers (e.g., Darvocet, Percocet, and methadone), sedatives (i.e., barbiturates), stimulants (e.g., methamphetamine, methedrine, Ritalin), hallucinogens (e.g., LSD, psylocibin, MDMA), inhalants (e.g., nitrite, "poppers", lighter fluid), marijuana, and tranquilizers (e.g., Clonazepam, Diazepam, Xanax). SA was based on participants' responses to sets of items that aligned with the DSM-IV diagnostic criteria. A participant was categorized as experiencing a SA if they answered positively to at least three item-criteria for that substance (American Psychiatric Association, 1994). Hence, each SA was operationalized as a dichotomous variable.

2.2.3. Suicidal thoughts and behaviors

Suicidal ideation and planning as well as suicide attempt in the past year were operationalized based on specific dichotomous items (i.e., "At any time in the past 12 months, did you seriously think about killing yourself / make plans to / try to kill yourself?").

2.3. Statistical analysis

The current study employed a multi-step modeling strategy. To begin, we estimated a series of multiple logistic regression models for each wave from 2008 to 2020, where SAs as well as sociodemographic and contextual factors served as predictors and STB as outcome variables. For each predictor we extracted odds ratios (ORs) along with their 95 % confidence intervals. We also calculated Cohen's *d* for a given OR using the formula provided by Chen et al. (2010) and based on the STB outcome's rate in the SA-free subgroup. To determine which SAs were associated with an increased likelihood of suicidal ideation and planning as well as suicide attempt, we averaged ORs, their confidence limits, and Cohen's *d* over all waves.

Before establishing the selection criteria, we identified two clusters representing the number of years in which a certain SA was a statistically significant predictor for STB ("0 to 6 years" – infrequent predictor, 19 entries; "10 to 13 years" – highly frequent predictor, 14 entries across the three STB, respectively). Then, we defined a predictor as stable and reliable by applying the following data-driven criteria: (i) a statistically significant OR ($p < .05$) in at least ten of the thirteen survey years (i.e., highly frequent predictor), (ii) average OR's 95 % confidence intervals excluding the value 1 (i.e., null effect of the predictor), and (iii) an average Cohen's $d \geq .20$ (not negligible effect size; Cohen, 1988). In order to account for variability across the waves, the average value for the years in which a substance was statistically significant was computed and then weighted by the years of significance. For instance, mean values of a significant predictor over 10 out of 13 years were reduced by a weight factor of 0.78 (i.e., 10/13). By doing so, we adopted a cautious approach in order to provide reliable, replicable, and meaningful results.

Following the identification of the predictors, we assessed their predictive accuracy, i.e., the model's ability to correctly classify participants as reporting one of the three STB (e.g., ideation, planning, or attempt). To do so, we calculated the area under the receiver operating characteristics curve (AUC) of four distinct multiple logistic regression models, namely the baseline model listing only sociodemographic and contextual factors (model 1), the baseline plus selected SAs (model 2), baseline plus unselected SAs (model 3), and baseline with all the SAs (model 4) across the three STB. For each wave, we first fitted model 1, and subsequently model 2. Alternative to model 2, we entered the unselected predictors (model 3). Finally, we fitted the full model with all SAs (model 4). Then, we extracted the predicted probability of the outcome for each wave across the four models, probability that we used to estimate the receiver operating characteristics (ROC) curve and quantify the area under the curve (AUC) (Robin et al., 2011). For interpreting a logistic model's predictive performance from the AUC, we followed the guidelines proposed by Hosmer and Lemeshow (2000), namely AUC = 0.5, no discrimination; 0.5 < AUC < 0.7, poor discrimination; 0.7 ≤ AUC ≤ 0.8, acceptable discrimination; AUC > 0.8, good to excellent discrimination.

The AUCs were compared to test if the model with reliable and stable predictors (model 2) showed (i) a greater predictive accuracy than the baseline model (model 1), (ii) a greater predictive accuracy than the model with unselected predictors (model 3), and (iii) a similar predictive accuracy to the full model with all the SA predictors (model 4). Within each wave and across each STB outcome, we compared the four models' AUCs using the DeLong test (Cleves, 2002; Robin et al., 2011).

Moreover, we submitted the models' AUC over the thirteen waves to a repeated measure ANOVA with two factors, namely STB (e.g., ideation, planning, and attempts) and Model (e.g., model 1, 2, 3, and 4). The purpose of this analysis was to determine if the three hypotheses were equally valid for each of the three STB outcomes (i.e., non-significant Model × STB interaction term). Additionally, we were able to assess the general predictive value of the four models for the three STB outcomes by testing for the main effect of the Outcome factor. We also calculated the Bayes Factor (BF_{10}) for the aforementioned analyses (Jarosz and Wiley, 2014; Morey and Rouder, 2022).

To measure the improvement in the predictive accuracy of a selected model compared to a baseline model, we calculated the V-statistic (Ho, 2009; Macmillan and Creelman, 2004):

$$V = \sqrt{2}\Phi^{-1}(\mathrm{AUC}),$$

where phi represents the inverse of the standard normal cumulative distribution function. AUC values are expressed as the standard deviation from the diagonal chance line in receiver operating characteristic (ROC) plots. A value of AUC=0.5 indicates no prediction, resulting in $V = 0$. This ratio-scale measure allows us to calculate the percentage increase or decrease in predictive performance between two models

3. Results

3.1. Identification of the stable and reliable predictors for suicidal ideation, planning, and attempts

The complete set of logistic models' results for each wave across suicidal ideation, planning, and attempt is available in Table S2. Regarding sociodemographic and contextual characteristics, increasing likelihood of suicidal ideation, planning, and attempt throughout the thirteen waves was related with gender (female, average ORs = 1.27, 1.34, 1.40 respectively; $p < .05$), race (multi-racial, average ORs = 1.22, 1.34, 1.70 respectively; $p < .05$), and mobility (participants who moved more than once, average ORs = 1.53, 1.67, 2.10 respectively; $p < .05$). Moreover, a protective role was played by age (> 25 years, average ORs = 0.42, 0.38, 0.31 respectively; $p < .001$), family income (> $19,999, average ORs = 0.80, 0.71, 0.71 respectively; $p < .05$), and better physical health (average ORs = 0.65, 0.62, 0.65 respectively; $p < .001$).

Average ORs, confidence limits, and Cohen's d values for SAs are presented in Table 1, while the year-specific results are shown in Table S3. SAs associated with alcohol, pain relievers, marijuana, and cocaine were selected as stable and reliable predictors for suicidal ideation and planning. For suicide attempt, the same SA predictors were selected, with the exception of cocaine.

3.2. Predictive accuracy of the selected predictor models

The AUC values, along with 95 % confidence intervals, of the four logistic models (e.g., 1, 2, 3, and 4) fitted over the thirteen waves across suicidal ideation, planning, and suicide attempt are presented in Table S4. In summary, all the four models achieved an acceptable predictive accuracy ($0.7 \leq \mathrm{AUCs} \leq 0.8$) across the STB outcomes, with model 2 (overall $M = 0.77$, SD = 0.039) showing a greater predictive accuracy than model 1 (overall $M = 0.74$, SD = 0.039) and model 3 (overall $M = 0.75$, SD = 0.041), and comparable predictive accuracy to model 4 (overall $M = 0.77$, SD=0.040) (Fig. 1).

The DeLong test on AUCs within each wave and across each outcome (see Table S4) revealed that model 2 was significantly more predictive than model 1 in 38 of 39 tests (Bonferroni-corrected $ps < 0.002$), significantly more predictive than model 3 in 22 of 39 tests (Bonferroni-corrected $ps < 0.048$), and not significantly different from model 4 in 30 of 39 tests (average Bonferroni-corrected $ps = 0.570$).

The repeated measure ANOVA (Model × STB outcome) on AUCs over the thirteen waves showed a statistically significant main effect of Model, STB outcome, and their interaction (Table S5). The main effect of Model was qualified by model 2 yielding AUC values ($M = 0.766$, SD = 0.020, $V = 1.028$) that were greater than those of models 1 and 3 ($M = 0.743$, SD = 0.022, $V = 0.923$; $M = 0.754$, SD = 0.021, $V = 0.970$, respectively), but slightly lower than those of model 4 ($M = 0.770$, SD = 0.020, $V = 1.045$) (see Fig. 1). In other words, model 2 showed an increase of 11.38 %[1] of predictive accuracy over model 1, and 5.98 % over model 3, and a decrease of 1.63 % over model 4. The main effect of STB outcome was due to the fact that all four estimated models provided distinct and decreasing AUC values in predicting suicide attempt ($M = 0.800$, SD = 0.020; $V = 1.190$), planning ($M = 0.756$, SD = 0.024; $V = 0.980$[vs attempt: −17.65 %]), and ideation ($M = 0.719$, SD = 0.020, $V = 0.819$[vs attempt: −31.17 %; vs planning: −16,43 %]). Although statistically significant, the interaction Model × STB outcome was not confirmed by the Bayesian analysis ($BF_{10} = 0.08$). Therefore, we did not further qualify the two main effects presented (see Table S5 and Fig. 1).

3.3. Clinical utility of self-reported alcohol addiction

Given that self-reported alcohol addiction had the greatest effect size among the SAs (Table 1 and Table S3), we evaluated its predictive accuracy compared to all the other ten SAs (Fig. 2). Model 2 was modified to include model 1 and alcohol addiction only (model 2b). Similarly, model 3b included model 1 and all the other SAs. The AUC values and their 95 % confidence intervals are presented in Table S4. The DeLong test on AUCs within each wave and across outcomes (Table S6) revealed that model 2b (baseline + alcohol SA) was significantly more predictive than model 1 in 34 of 39 tests (Bonferroni-corrected $ps < 0.018$), but not significantly less predictive than model 3b (baseline + ten unselected SAs) in all 39 tests (Bonferroni-corrected $ps = 0.960$).

The repeated measure ANOVA on AUCs over the thirteen waves showed a statistically significant main effect of Model and STB outcome (Table S7). The main effect of Model was qualified by model 2b yielding AUC values ($M = 0.759$, SD = 0.020; $V = 0.993$) that were greater than those of models 1 ($M = 0.743$, SD = 0.022; $V = 0.923$), and comparable to model 3b ($M = 0.761$, SD = 0.021; $V = 1.001$). In other words, model 2b showed an increase of 7.58 % of predictive accuracy over model 1, and a decrease of 0.80 % over model 3b. As previously indicated, the main effect of Outcome was due to a reduction in AUC values associated with suicide attempts ($M = 0.795$, SD = 0.021, $V = 1.167$), planning ($M = 0.752$, SD = 0.024; $V = 0.962$[vs attempt: −17.57 %]), and ideation ($M = 0.715$, SD = 0.020; $V = 0.804$[vs attempt: −31.11 %; vs planning: −16.42 %]). Despite being statistically significant, the interaction term was not supported by Bayesian analysis (BF10 = 0.11). Therefore, we did not further explore this effect.

4. Discussion

The aim of this exploratory study was to comprehensively investigate the relationship between eleven self-reported substance addictions (SAs), and suicidal ideation, planning, as well as suicide attempt. The analysis revealed that addiction to alcohol, pain relievers, marijuana, and cocaine in the past year were substantially and reliably linked to all types of suicidal thoughts and behaviors (STB), while addiction to cocaine was not associated to suicide attempt. The predictive accuracy of the selected SAs was confirmed by the AUC ROC analysis. Model 2, comprising the selected SAs, showed (i) a larger predictive accuracy (increase of 11.38 %) than considering the sociodemographic and contextual factors only (model 1), (ii) a larger predictive accuracy (increase of 5.98 %) than considering the larger subset of unselected SAs

[1] The increase of predictive accuracy can be expressed as percentage by computing the ratio between two V statistics. In this case, we computed the ratio between the selected model (model 2) and baseline model (model1), namely 1.028/.923=1.1138 (or increase of 11.38%).

Table 1
Average ORs, confidence limits, and Cohen's d values over all waves (2008 – 2020).

	Suicidal ideation					Suicidal planning					Suicidal attempt				
	Weight	*d*	OR	2.50 %	97.50 %	Weight	*d*	OR	2.50 %	97.50 %	Weight	*d*	OR	2.50 %	97.50 %
Alcohol	13	**0.45**	**2.51**	**2.17**	**2.9**	13	**0.39**	**2.60**	**2.05**	**3.26**	13	**0.41**	**2.97**	**2.16**	**4.03**
Pain relievers	13	**0.39**	**2.24**	**1.62**	**3.08**	11	**0.26**	**1.83**	**1.11**	**2.88**	12	**0.28**	**2.13**	**1.18**	**3.65**
Marijuana	13	**0.38**	**2.19**	**1.77**	**2.68**	12	**0.26**	**1.87**	**1.34**	**2.55**	11	**0.20**	**1.62**	**1.04**	**2.43**
Cocaine	13	**0.33**	**1.99**	**1.25**	**3.1**	10	**0.27**	**1.84**	**1.00**	**3.22**	4	0.13	0.92	0.44	1.79
Inhalants	4	0.31	2.1	0.45	11.97	1	0.05	0.41	0.10	1.55	2	0.08	0.03	0.20	23.65
Sedatives	5	0.29	1.68	0.86	4.77	5	0.28	2.04	0.62	6.16	5	0.26	2.06	1.04	13.02
Tranquilizers	5	0.18	0.99	0.53	1.82	5	0.18	1.17	0.53	2.44	2	0.10	0.83	0.31	1.98
Heroin	5	0.13	0.78	0.46	1.28	0	–	–	–	–	3	0.10	0.78	0.30	1.81
Stimulants	5	0.13	0.78	0.44	1.35	4	0.14	0.96	0.45	1.89	6	0.20	1.47	0.58	3.3
Nicotine	13	0.12	1.3	1.14	1.48	12	0.14	1.37	1.11	1.68	12	0.15	1.44	1.08	1.89
Hallucinogens	2	0.08	0.46	0.19	1.05	2	0.08	0.56	0.20	1.41	3	0.13	1.01	0.30	2.9

Weight: number of years in which the predictor is statistically significant.

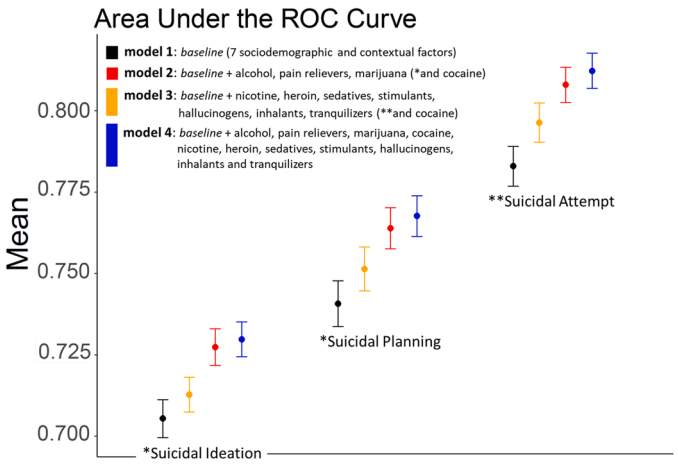

Fig. 1. Average AUC values for the models 1, 2, 3, and 4 across the three suicidal outcomes.

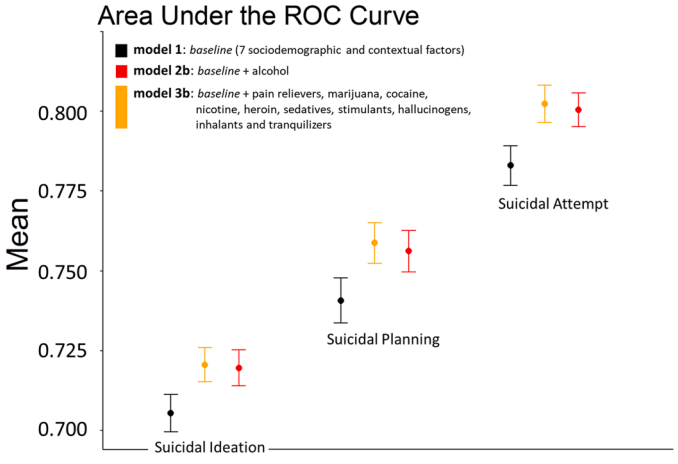

Fig. 2. Average AUC values for the models 1, 2b, and 3b across the three suicidal outcomes.

(model 3), and (iii) similar predictive accuracy (decrease of 1.63 %) to the model where all the predictors were considered simultaneously (model 4).

Overall, our results confirmed previous evidence indicating the possible link between pain relievers, alcohol, cocaine, and marijuana and increased risk for suicidal thoughts and behaviors (Conner et al., 2019; Darvishi et al., 2015; Hesse et al., 2020; Pavarin and Fioritti, 2018; Schmidt et al., 2020). However, our study adds to our current understanding of this phenomenon, by clarifying the specific contribution of each of these SAs to suicidal outcomes, as described below.

Addiction to marijuana was reliably linked to each STB outcome. This result is in line with a growing body of literature, where cannabis use disorder and chronic cannabis use were associated with an enhanced risk for suicidal ideation and attempt (for reviews, see Armoon et al., 2021; Borges et al., 2016). In particular, the meta-analysis conducted by Breet and colleagues (2018) found a positive correlation with suicidal ideation and attempt for both non-disordered and disordered use. Thus, it might be interesting to consider different levels of severity of cannabis use in the future in order to clarify whether what is related to STB is the use itself or its severity. Lastly, in contrast to a previous study (Delforterie et al., 2015), we found a positive association between addiction to marijuana and suicidal planning. A possible explanation may be due to differences in the type and size of the sample, as ours was of epidemiological magnitude and highly representative of the US general population.

Cocaine addiction emerged as a risk factor only for suicidal ideation and planning, whereas it was not a significant predictor for suicide attempt. These findings are partially consistent with previous studies, as cocaine addiction and cocaine daily use are usually related also to suicide attempt (Abdalla et al., 2019; Borges et al., 2000; Garlow et al., 2003; Jangal et al., 2022; Moçambique et al., 2022; Pavarin and Fioritti, 2018). The reason for the inconsistency may be due to the fact that, unlike most of previous studies, we considered multiple addictions simultaneously. By doing so, this procedure might have partialed out the spurious contribution of cocaine addiction for this specific outcome. Moreover, it is frequent for people who use cocaine, to also use other substances, such as alcohol or cannabis (see meta-analysis Liu et al., 2018). For this reason, it may be necessary to broaden the focus of future studies to explore polysubstance addiction in relation to STB.

Addiction to pain relievers emerged as associated to all three STB. Pain relievers are a broad set of drugs that typically include pharmaceutical opioids, such as OxyContin and Methadone (U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality, 2010). The phenomenon of illegally using these substances is known as prescription opioid misuse and it is significantly associated with increased odds of suicidal ideation, planning, and attempt (Davis et al., 2020). However, previous studies reported inconsistent findings. For instance, Borges and colleagues (2000) showed that pain reliever addiction was unrelated to suicide attempt, while other studies reported that opioid use disorder was associated with suicidal ideation and attempt (Armoon et al., 2021; Chan et al., 2014). By relying on large and representative samples, our research offers additional insights into this subject and reinforces the connection between addiction to pain relievers and suicidal thoughts and behaviors.

Importantly, our study revealed that alcohol addiction was the strongest predictor of concurrent STB, with overall effect size of

moderate to strong magnitude. This finding was in line with previous literature, showing the tight connection between addiction to this substance and the increased risk for suicidal thoughts and behaviors (see meta-analyses Armoon et al., 2021, Darvishi et al., 2015). Furthermore, our findings showed that self-reported alcohol addiction possesses significant clinical utility, as its predictive accuracy almost matches that of considering all ten other SAs simultaneously (decrease of 0.8 %). Therefore, alcohol could be considered an extremely effective concurrent predictor for suicidal thoughts and behaviors in terms of the cost-benefit tradeoff as well as an important – and relatively easy to investigate – marker for potential suicidal risk.

The predictive role of some substance addictions remains unclear. Addictions to inhalants, sedatives, and heroin were not stable through the years, with largely fluctuating predictive values. With regard to heroin and sedatives, while most overdose survivors do not link their experience to a suicide attempt, intentional overdose is an existing – although elusive – phenomenon (Bohnert et al., 2018). In fact, assessing a person's motive via analyzing memories is a research method subject to a variety of biases (Bohnert and Ilgen, 2019). As regards inhalants and hallucinogens, our unclear results may be due to the small number of people who were self-reportedly diagnosed with addiction to those drugs in relation to the whole sample. In future studies, it could be interesting to expand our understanding of the relationship between overdose and suicidal intention as well as to focus on an oversampled group of individuals with inhalant and hallucinogen addiction.

By examining the effects of the sociodemographic and contextual factors, our findings suggested that a specific set of characteristics may be associated with elevated risk for STB: being a young adult (18–25), being a female, having lower income, having moved more than one time in the previous year, showing lower physical health, and being multiracial are the characteristics that carry a high risk for suicidal ideation, planning, and attempt. These findings aligned to previous literature that clarifies that gender, age, income, social instability, and health are important risk factors for STB (Armoon et al., 2021; Kye and Park, 2017; Maniam et al., 2014; Miret et al., 2014).

Our investigation is characterized by several strengths. First, we thoroughly investigated to what extent a large gamut of SAs have a statistical link with different STB, while previous studies have typically focused on them individually or on small subset of SAs. Second, we drew upon data from an epidemiological multi-wave study with a very large sample size and participants recruited to be representative of the US general population. Third, we systematically analyzed data referring to 13 years, from 2008 to 2020, reporting solid evidence about the relationship between SAs and STB. Lastly, our study paves the way for important clinical and preventive applications, which will be discussed later.

Nevertheless, our study has weaknesses as well. First, it was not possible to explore the longitudinal predictive value of SAs with respect to future STB. Future studies should specifically focus on the temporal relationship between these two classes of phenomena. Second, this study relied on self-reported information, with clinical status being derived from these reports rather than through diagnostic assessment conducted by a mental health professional. This methodology carries the risk of multiple biases, which may stem, for example, by social desirability or self-deception (Huang et al., 1998; Robins et al., 2009). Third, given that we aimed at clarifying the specific contribution of each SA, we did not investigate the possible impact of polysubstance addiction. Fourth, we did not consider individuals under the age of 18, because not all the younger participants were routinely screened for STB. Finally, the number of participants who planned and/or engaged in a suicide attempt was somewhat restricted and we did not consider completed suicide. Therefore, it would be interesting to oversample participants with the less frequent STB, in order to better understand the specific relationship between these factors and SA.

Several directions for future research are worth commenting on. Although nicotine addiction was stably significant through the years in our study, the average effect size was very small, and it was therefore excluded by the selection algorithm. In the future, it could be interesting to specifically analyze the importance of this substance addiction, as in 2020 a large part of the U.S. adults (i.e., 19 %) used tobacco products (Cornelius et al., 2022). Another promising point could be to investigate the impact of the age of onset of the addiction as it is known that an early onset has a substantial impact on mental health and, in turn, STB (Borges et al., 2017).

Important implications for both clinical practice and preventive interventions can be derived from this study. First, given the proven relation between SAs and STB, it may be useful to promote screening programs for STB among people with alcohol, cannabis, cocaine and pain reliever addiction, in order to inform and prevent possible negative outcomes. Moreover, self-reported alcohol addiction alone could represent an informative and feasible marker for assessing concurrent STB risk. For instance, implementing screening tests for STB in people with only alcohol addiction, or even high rates of alcohol consumption, may be an important prevention tool, while maximizing valuable resources (e.g. personnel, time, effort) (Canapary et al., 2002). Second, despite the cross-sectional nature of our study, it seems plausible that preventing addiction to alcohol, marijuana, pain relievers, and cocaine in the general population may lead to a reduction in the levels of STB, and maybe in suicidal risk in general. Although research on this matter led to mixed findings, it seems promising that clinical interventions specifically developed for targeting the relation between alcohol addiction and suicidal outcomes may reach this important preventive goal (Giesbrecht et al., 2024). Third, our results may also have implications for public health policy, especially considering that at least three of our selected SAs, such as alcohol, cannabis, and pain relievers, are usually either legal or legally accessible under specific conditions. For this reason, it would be important to inform both the general population and mental health professional community about the increased STB risk for individuals experiencing addiction to these substances.

In conclusion, self-reported addictions to pain relievers, alcohol, marijuana, and cocaine can be considered as important risk factors for concurrent suicidal thoughts and behaviors beyond the influence of socio-demographical and contextual factors. More specifically, particular attention should be paid to alcohol addiction as a strongly informative marker for STB.

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Ethical approval

The Ethics Committee of the University of Trieste (Italy) approved this secondary analysis study.

CRediT authorship contribution statement

Angela Giugovaz: Conceptualization, Data curation, Formal analysis, Methodology, Validation, Writing – original draft, Writing – review & editing. **Michele Grassi:** Data curation, Formal analysis, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **Igor Marchetti:** Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors have no conflicts of interest to disclose.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2024.115821.

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