

ARTICLE

Cannabis use disorder, alcohol use disorder, and suicidal ideation within a social determinants of mental health framework: Insights from a network analysis

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Abstract

Background: Alcohol and cannabis use disorders are among the most prevalent substance use disorders worldwide. They frequently co-occur and show high comorbidity with psychological distress and suicidal ideation. Although these relationships are well established, their underlying structure remains unclear, as mental health is embedded within a complex network of individual, social and environmental factors. The aim of this study was to explore the interplay between alcohol and cannabis use disorders, psychological distress and suicidal ideation within the context of sociodemographic factors and social determinants of mental health using network analysis.

Design: Cross-sectional secondary analysis of nationally representative survey data.

Methods: Data were drawn from the 2021 National Survey on Drug Use and Health ($N=44,360$). A mixed graphical model was estimated and partitioned into three communities (psychological, sociodemographic, social determinants of mental health). Bridge centrality and odds ratio analyses were conducted to identify key nodes and quantify associations.

Results: Sociodemographic variables (e.g., age, sexual orientation) showed more direct connections to mental health outcomes, whereas social determinants (e.g., housing instability, employment) occupied more distal positions. Cannabis use disorder and psychological distress emerged as key bridging nodes linking sociodemographic and structural domains to broader mental health outcomes, including

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suicidal ideation and alcohol use disorder, suggesting pathways through which contextual risk translates into psychological vulnerability.

Conclusions: Mental health outcomes are shaped by both individual and structural factors. Targeting key bridging nodes (e.g., cannabis use disorder and psychological distress) may improve prevention and intervention, alongside policies addressing adverse social conditions.

KEYWORDS

alcohol use disorder, cannabis use disorder, psychological distress, social determinants of mental health, sociodemographic factors, suicidal ideation

Practitioner points

- Cannabis use problems and psychological distress may signal broader risk.
- Assessing social factors (e.g., housing, employment) improves risk evaluation.
- Age and sexual orientation are key markers of vulnerability.
- Interventions should address both individual symptoms and social conditions.

INTRODUCTION

Substance use disorders (SUD) represent a major public health concern: in the United States alone, approximately 46.3 million individuals were estimated to meet diagnostic criteria in 2021 (SAMHSA, 2022). Alcohol Use Disorder (AUD) and Cannabis Use Disorder (CUD) are the most prevalent forms, affecting an estimated 29.5 million and 16 million individuals respectively (SAMHSA, 2022). The two conditions are deeply intertwined, in fact, alcohol and cannabis are frequently used together (McCabe et al., 2021), and their disordered forms show high comorbidity (Yurasek et al., 2017). Both are also strongly associated with psychological distress, which is characterized by subclinical depressive and anxiety symptoms, and suicidal ideation (SI) (Armoon et al., 2021; Mirowsky & Ross, 2002; Onaemo et al., 2021), which in 2021 affected approximately 12.3 million individuals in the United States (SAMHSA, 2022). Recent large-scale evidence further highlights the role of AUD and CUD as robust predictors of SI, with AUD showing predictive accuracy comparable to that of 10 other substance addictions combined (Giugovaz et al., 2024).

Although the associations among psychological distress, suicidality and substance use are well documented, their configuration is far from straightforward. SUDs are widely recognized as risk factors for SI (Borges et al., 2016). At the same time, elevated self-harm-related ideation may increase vulnerability to substance use in specific contexts (Borges et al., 2017), suggesting reciprocal influences rather than a simple unidirectional pathway. Psychological distress further complicates this picture, as it is closely intertwined with both suicidality and substance misuse (Flynn et al., 2004; Rainbow et al., 2023). These conditions frequently co-occur and overlap, and may mutually reinforce one another, while contextual factors can play a crucial role in shaping these dynamics (Kirkbride et al., 2024; Lund et al., 2018).

Epidemiological research consistently highlights that sociodemographic factors shape the onset, persistence and remission of mental suffering (Drapeau et al., 2012), among which substance-related disorders, SI and psychological distress (Grant et al., 2015; SAMHSA, 2022; Thompson et al., 2019). Age, for example, shows a differential pattern across conditions. Solmi et al. (2022) report that substance use and addictive disorders peak at 19.5 years, with a secondary peak at 44.5 years. Mood

disorders show peak incidences at 20.5 and 33 years, while SI is most prevalent in late adolescence and early adulthood (Giugovaz et al., 2024). Gender differences also play a key role: women report higher levels of distress and suicidality (Drapeau et al., 2012; Giugovaz et al., 2024) while men are more likely to meet the criteria for AUD and CUD (Boyd et al., 2015; Drapeau et al., 2012). Similar patterns are observed among ethno-racial and sexual minorities (Giugovaz et al., 2024; SAMHSA, 2022; Thompson et al., 2019).

Beyond individual-level characteristics, recent frameworks emphasize the importance of the broader environmental and structural contexts in which individuals are embedded. These are commonly referred to as the social determinants of health. The World Health Organization defines them as *'the non-medical factors that influence health outcomes, including the conditions in which people are born, grow, work, live, and age, as well as the systems shaping these conditions'* (World Health Organization, 2021). Of particular interest are the social determinants of mental health (SDMH), which refer to the structural and social conditions that shape mental health outcomes. They include discrimination, socioeconomic inequalities, financial hardship, unemployment, limited access to health care, housing instability and population density. These conditions may influence both exposure to stressors and access to protective resources (Kirkbride et al., 2024).

Empirical evidence underscores the relevance of these determinants in understanding SUDs, suicidal ideation and psychological distress. Chronic cannabis users, for example, are more likely to drop out of college, hold stressful jobs and earn lower incomes compared to non-users (Thompson et al., 2019). Similarly, lower income and unemployment have been associated with greater severity of AUD and SI (Grant et al., 2015; Harmer et al., 2024; SAMHSA, 2022). Living alone or in smaller households has also been linked to alcohol and cannabis use disorders and SI (Forkmann et al., 2012; Joutsenniemi et al., 2007; Van der Pol et al., 2013). Moreover, chronic minority stress, including experiences of discrimination, social exclusion and cultural stigmatization (Meyer, 2003), is known to increase vulnerability to SUDs, SI and psychological distress (Huerta & Borgonovi, 2010; Salway et al., 2019; SAMHSA, 2022).

Taken together, these findings suggest that AUD, CUD, psychological distress and SI rarely emerge from isolated risk factors. Instead, they reflect a complex interplay of psychological, social and structural influences. Traditional predictor–outcome models may therefore capture only part of this picture. By focusing on a limited set of independent and dependent variables, they often examine one outcome at a time and may overlook how these factors operate together within a broader system.

Network analysis offers a framework that is particularly well suited to capturing this level of complexity (Borsboom & Cramer, 2013). A network model can be understood as a structural 'snapshot' of the system at a given moment, depicting how variables are arranged in relation to one another and how clusters of factors are interconnected.

Despite its considerable potential, the application of network analysis to the interplay between different domains remains largely unexplored. To date, this approach has been predominantly used to examine symptom structures of specific disorders, including addiction (Rhemtulla et al., 2016), suicidal cognitions (De Beurs et al., 2019) and psychological distress (Beard et al., 2016). The present study addresses this gap by mapping the complex dynamics among AUD, CUD, psychological distress and suicidal ideation within a systemic framework that incorporates sociodemographic and SDMH factors. By disentangling these relationships, the study aims to provide a more integrated understanding of potential leverage points for prevention and clinical practice.

To achieve these objectives, we relied on data from the National Survey on Drug Use and Health (NSDUH), a large epidemiological study on substance addictions and mental health in the United States. Using network analysis, we pursued three goals: to explore the connections among AUD, CUD, psychological distress and SI within the broader sociodemographic and SDMH context; to elucidate the specific *bridge* pathways (Jones et al., 2019) through which psychological, SDMH and sociodemographic characteristics are interconnected; and to identify which factors are most closely connected to AUD, CUD, psychological distress and SI. To address this last aim, we additionally derived odds ratios from the estimated network to quantify the strength of the association between each sociodemographic and SDMH factor and the four mental health outcomes.

METHOD

Sample

This study was based on National Survey on Drug Use and Health (NSDUH) data referring to year 2021 (U.S. Department of Health and Human Services et al., 2022). The NSDUH is an annual epidemiological survey sponsored by the Substance Abuse and Mental Health Services Administration (SAMHSA). It is designed to produce nationally representative estimates of substance use and mental health in the US civilian, noninstitutionalized population aged 12 or older. Participants are recruited through a multistage area probability sample design that progressively narrows from geographic areas to households, with up to two eligible individuals selected per household. For the present study, we restricted analyses to respondents aged 18 or older. Further details on the NSDUH sample design and data collection procedures are available in the survey's official methodological documentation (Center for Behavioral Health Statistics and Quality, 2022). The total sample, representative of the US American population, consisted of 44,360 adult individuals (55.71% female; age: 18–25, 29.16%; 26–34, 20.15%; 35–49, 26.75%; 50–64, 12.18%; ≥65, 11.75%).

The original NSDUH data collection received Institutional Review Board approval from RTI International, with informed consent obtained from all participants. The Ethics Committee of the University of Trieste (Italy) additionally approved this secondary analysis study.

Measures

Sociodemographic variables

The sociodemographic variables considered were age, gender, race/ethnicity, sexual orientation and having religious beliefs¹ (for more information, Table 1).

Social determinants of mental health

The social determinants of mental health considered were poverty,² education, employment, access to full or partial health insurance,³ housing instability (i.e., the number of times a person moved), the number of people living in the same household and the size of the city of residence. All the characteristics that possess temporal qualities referred to the previous year (for more information, Table 1).

Alcohol and cannabis use disorders

Past-year AUD and CUD were assessed using the standardized substance use disorder module developed by SAMHSA for the NSDUH. The module is based on the 11 DSM-5 criteria for substance use disorder and is administered separately for alcohol and cannabis (e.g., 'During the past 12 months, were there times when you had a strong urge to drink alcohol [or use marijuana or hashish]?'; 'During the

¹The latter was assessed with the item 'Your religious beliefs are a very important part of your life' (rated from strongly disagree to strongly agree) and recoded as binary.

²Poverty indicates a person's family income relative to poverty thresholds, based on the US Census Bureau.

³Being covered by one of the following health insurances: Medicare, Medicaid/CHIP, Tricare, Champus, ChampVA, VA, Military, private insurance or other health insurance.

TABLE 1 Descriptive statistics of the analytic sample (N= 44,360).

N= 44,360		
	Variable	%
Gender	Female	55.71
Age	18–25 years	29.16
	26–34 years	20.15
	35–49 years	26.75
	50–64 years	12.18
	65 + years	11.75
Race/ethnicity	White	63.09
	Black	10.78
	Native American/Alaska Native	.95
	Native Hawaii/Other Pacific Islands	.38
	Asian	5.68
	More than one race	3.86
	Hispanic	15.26
Sexual orientation	Heterosexual	88.57
	Homosexual	2.97
	Bisexual	8.46
Religious beliefs	Yes	60.14
Education	Less than high school	8.99
	High school grad	23.12
	Some college/Associate Degree	30.29
	College Graduate	37.60
Employment	Full time	49.03
	Part-time	14.83
	Unemployed	6.01
	Other	30.13
Poverty	Yes	16.10
Urbanicity	Large metro	44.36
	Small metro	38.19
	No metro	17.46
Health insurance	Yes	89.91
Household members	1	14.29
	2	30.50
	3	20.83
	4	18.98
	5	9.14
	6+	6.27
Housing instability (N. times moved)	Never	75.99
	One time	16.75
	Two times	5.02
	Three or more times	2.24
Psychological distress	Yes	10.04

(Continues)

TABLE 1 (Continued)

N=44,360		
	Variable	%
AUD	Yes	12.80
CUD	Yes	7.82
SI	Yes	6.69

Note: All variables are categorical and reported as percentages within each level.
Abbreviations: AUD, alcohol use disorder; CUD, cannabis use disorder; SI, suicidal ideation; SDMH, social determinants of mental health.

past 12 months, did you have any long-lasting or repeated problems with emotions or mental health that were caused or made worse by drinking alcohol [or using marijuana]?”). Each criterion is scored dichotomously. Consistent with the DSM-5 algorithm, respondents who met at least two criteria were classified as having a past-year AUD or CUD, corresponding to at least mild severity (American Psychiatric Association [APA], 2013). The full list of items is provided in [Supplementary Material \(Table S1\)](#).

SI and psychological distress

SI in the past year was operationalized through a specific dichotomous item (i.e., ‘At any time in the past 12 months, did you seriously think about trying to kill yourself?’). Psychological distress in the past month was evaluated through the Kessler Psychological distress scale—6 items (K-6; Kessler et al., 2002). Following the NSDUH’s guidelines, we classified psychological distress as present if the K6 score exceeded the midpoint of the total score (i.e., 13 out of 24).

Statistical analysis

All analyses were conducted using R version 4.4.0 (R Core Team, 2024). Descriptive statistics were examined before estimating a Mixed Graphical Model (MGM) with categorical variables, following Haslbeck and Waldorp’s procedure, via the R-package ‘mgm’ (2015, 2020). The Extended Bayesian Information Criterion (EBIC) was used as the tuning parameter for the regularization, as it performs well in this context (Haslbeck & Waldorp, 2020).

A Mixed Graphical Model (MGM) is a network model that extends the Pairwise Markov Random Field framework to datasets containing both continuous and categorical variables (Haslbeck & Waldorp, 2015). In network analysis, variables are termed *nodes* and the associations between them are termed *edges*. These associations represent conditional dependencies after controlling for all other variables in the network. MGM estimation relies on a regularization procedure that produces sparse and interpretable networks by retaining only the most robust associations. In the resulting network, edge weights reflect the strength of the associations between nodes. In categorical networks, edge weights indicate only the presence and magnitude of associations, but their direction and the specific effects at the level of individual categories cannot be directly inferred from the network representation. Beyond these pairwise associations, nodes can be characterized by their position within the overall network.

Accordingly, the estimated network was visualized via the ‘qgraph’ package (Epskamp et al., 2012) and the strongest associations were identified by inspecting the largest edge weights. Node centrality was quantified using node strength, defined as the sum of the absolute edge weights connected to each node. Bootstrapped difference tests (Epskamp et al., 2018) were then conducted separately on edge weights and on node strength values to assess whether pairs of estimates differed significantly. A difference was considered significant when its 95% bootstrap confidence interval did not include zero. The

precision and stability of the network were further assessed with the 'bootnet' package: edge-weight accuracy was estimated through nonparametric bootstrapping with 95% confidence intervals, and the stability of edge and strength estimates was evaluated through case-dropping subset bootstrapping, summarized by the correlation-stability (CS) coefficient.

Aligned with the study's aims, the network was divided into three conceptual communities (i.e., groupings of nodes) namely mental health factors, sociodemographic factors and SDMH factors. Two bridge analyses were performed using the 'networktools' package (Jones, 2024) to identify the strongest bridge nodes linking mental health factors with the other two communities. Finally, odds ratios (ORs) were derived directly from the estimated MGM following Haslbeck (2020). This procedure transforms the conditional parameters of the network into ORs quantifying the association of each sociodemographic and SDMH factor with the four mental health outcomes (AUD, CUD, psychological distress and SI).

Additionally, to examine whether the findings were affected by the psychological impact of the COVID-19 pandemic, a covariate network analysis was conducted. The network was re-estimated after adding three COVID-19-related variables, concerning the perceived effect of the pandemic on (i) mental health, (ii) alcohol use and (iii) drug use. Following the procedure of Dalege et al. (2017), the two networks were then compared after excluding the three COVID-19-related covariates. The corresponding edge weights and node strength values were correlated using Spearman's rank correlation. A high correspondence would indicate that the original results were not affected by COVID-19-related influences.

As a sensitivity analysis, the network was also re-estimated using a more conservative EBIC hyperparameter ($\gamma = .50$), to assess the robustness of the network structure to the influence of the large sample size. Edge weights and node strength values from this alternative estimation were compared with those of the original network ($\gamma = .25$) using Spearman's rank correlation.

RESULTS

Descriptive statistics

The sociodemographic, social and mental health characteristics of the sample are summarized in Table 1. Most respondents self-identified as White (63.09%) and heterosexual (88.57%); 60.14% reported having religious beliefs. Regarding social determinants, 16.10% lived below the poverty threshold and 75.99% reported no housing relocations in the past year. With respect to mental health and substance use, 10.04% met criteria for psychological distress, 12.80% for AUD, 7.82% for CUD and 6.69% reported past-year suicidal ideation.

Network estimation, inference and stability

We estimated the categorical network (Figure 1). It was strongly inter-connected, with 105 of 120 non-zero edges, with sociodemographic factors interposing between mental health nodes and SDMH nodes. The local properties analysis showed that the most central node was age, followed by psychological distress and CUD, while the least central nodes were move, gender and the size of the city where the individual lives (Figure S1).

In terms of relative edge-strength, the edge between psychological distress and SI was the strongest one. Other strong edges that interested the psychological factors were the one between AUD and CUD, and age-CUD. The majority of the edges were significantly different from one another (Figure S2).

Regarding bridge strength, the strongest bridging nodes between psychological factors and sociodemographic communities were CUD, age, psychological distress and sexual orientation. These nodes demonstrated the highest degree of connectivity, reflecting their pivotal role in linking different domains of psychological and sociodemographic factors (Figure 2). The most significant bridging nodes

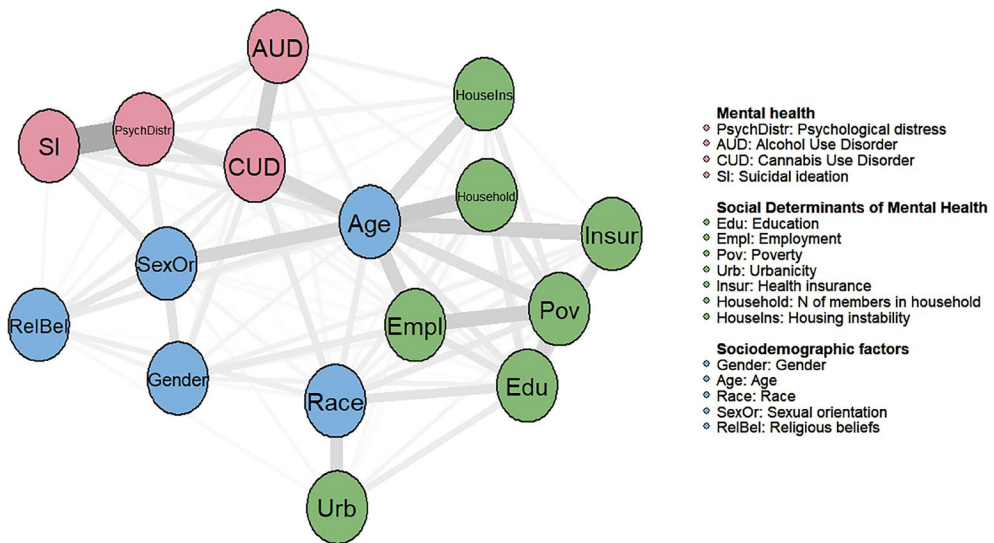


FIGURE 1 Network model clustered in three communities, namely mental health factors, social determinants of mental health factors and sociodemographic factors.

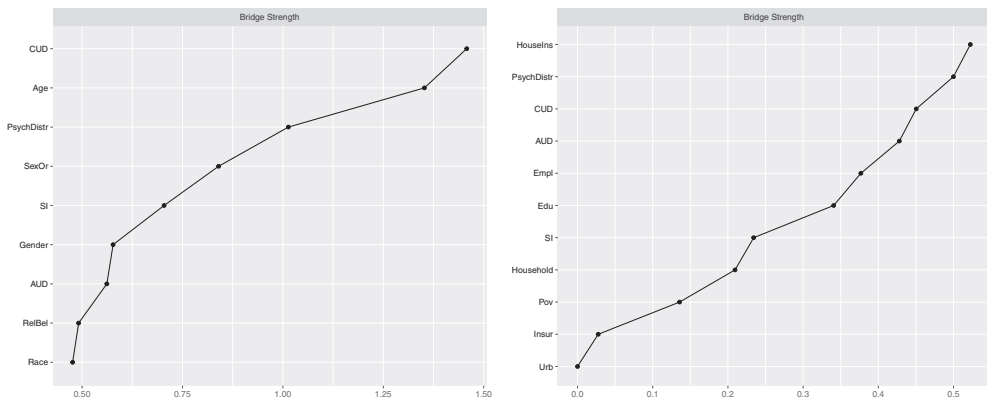


FIGURE 2 Bridge strength between psychological and sociodemographic communities, and between psychological and social determinants of mental health communities.

between psychological factors and SDMH were housing instability, psychological distress, CUD, AUD and employment. These variables exhibited a robust interconnection, underscoring their importance in mediating the relationship between psychological factors and social determinants. (Figure 2).

Stability analysis revealed that the estimation of edges was performed in a precise manner, with very narrow confidence intervals (Figure S3). Similarly, the estimated network was very stable in terms of edge and strength values, with CS coefficient equal to .75 for both indices (Epskamp et al., 2018). The stability of bridge strength estimates yielded CS coefficients of .75 for both pairs of communities examined, consistent with the stability observed for edge weights and node strength (Figures S4 and S5).

Odds ratio analysis

In line with the study's third goal, we examined which factors are more strongly associated with AUD, CUD, SI and psychological distress. Among the sociodemographic factors, the most significant

predictors across the four outcomes were age, sexual orientation and religious beliefs, while gender and race/ethnicity were primarily associated with mental distress, AUD and CUD but not SI. Among SDMH, house instability and employment status were the most transversal predictors for the outcomes, while education exerted its influence only on CUD and psychological distress, and the number of individuals in the household was specifically associated with AUD and CUD. Poverty, size of the city and health insurance were weakly associated with the mental health factors. All the results of the odds ratio (OR) analysis are presented in [Table 2](#).

Additional analysis

Regarding the COVID-19 covariate analysis, the resulting network was almost identical to the original one in terms of edges ($r_s = .956$) and strength values ($r_s = .976$), suggesting that our results were not affected by the pandemic. The network plot is available in the [Supplementary Material \(Figure S6\)](#).

Regarding the sensitivity analysis with the more conservative EBIC hyperparameter ($\gamma = 0.50$), edge weights and node strength values were highly correlated across the two networks ($r_s = .999$ and $r_s = .997$, respectively), indicating that the network structure was robust to this methodological choice. The network estimated with $\gamma = 0.50$ and the corresponding node strength values are presented in the [Supplementary Material \(Figure S7 and Figure S8, respectively\)](#).

DISCUSSION

The present study pursued three interconnected goals: to explore the connections among AUD, CUD, psychological distress and SI within the broader sociodemographic and SDMH context; to elucidate the specific bridge pathways through which psychological, SDMH and sociodemographic characteristics are interconnected; and to identify which factors are most closely connected to AUD, CUD, psychological distress and SI within the overall network structure. By modelling all variables simultaneously in a single network, we examined how these factors operate when considered together rather than in isolation. The analysis revealed strong interconnections between mental health and sociodemographic factors, and between them and SDMH factors.

Regarding the first objective, the network revealed a clear structural distinction between sociodemographic and SDMH factors in their relationship to mental health outcomes. Overall, sociodemographic factors showed more direct connections to psychological outcomes, whereas SDMH factors occupied more distal positions within the network. This pattern contrasts with the common view that broader structural determinants would exhibit closer associations with mental health outcomes (Kirkbride et al., 2024; Lund et al., 2018). At least two factors may explain this pattern. First, sociodemographic variables such as gender, race and sexual orientation are stable individual characteristics. They shape daily experiences, including exposure to discrimination, minority stress and unequal access to resources, which can translate more immediately into mental distress (Boyd et al., 2015; Thompson et al., 2019). For example, the effects of housing instability or unemployment may be amplified among racial minorities or young adults who already face social and economic disadvantages. Second, some sociodemographic indicators may be conceptually close to SDMH or even reflect unmeasured SDMH variables. Experiences of discrimination, for instance, are typically understood as a social determinant of mental health (Kirkbride et al., 2024). In this sense, characteristics such as race or sexual orientation may partly operate as proxies for chronic exposure to discrimination and other structural disadvantages, which could contribute to the apparent proximity between sociodemographic and SDMH nodes in the network.

Turning to the second objective, bridge analysis highlighted CUD and psychological distress as key nodes linking mental health to both sociodemographic and SDMH factors. Their position within the network places them at the intersection of multiple domains. Because of this central bridging role,

TABLE 2 Odds ratios (ORs) derived from the mixed graphical model.

		Psych distress	AUD	CUD	SI
Gender	Female	1.470	.768	.622	1.000
Age (Ref. category: 18–25)	26–34	.923	1.137	1.000	.943
	35–49	.703	1.212	.688	.903
	50–64	.506	.949	.377	.704
	65+	.240	.563	.193	.460
Race/ethnicity (Ref. category: White)	Black	.891	.927	1.294	1.000
	Native American/Alaska Native	1.000	1.202	2.106	1.000
	Native Hawaii/Other Pacific Islands	1.000	1.000	1.000	1.000
	Asian	1.000	.601	.524	1.000
	More than one race	1.000	1.000	1.360	1.168
	Hispanic	.931	1.000	1.000	1.000
Sex Or (Ref. c: Hetero)	Homo	1.644	1.160	1.282	1.523
	Bisex	2.017	1.080	1.868	2.474
Religious beliefs	Yes	.843	.805	.650	.813
Education (Ref. category: Not compl HS)	High school	1.020	1.000	1.000	1.000
	Some college	1.000	1.094	1.000	1.124
	College	.678	1.073	.534	.985
Employment (Ref. category: Full time)	Part-time	1.142	.900	1.067	1.103
	Unemployed	1.436	.942	1.475	1.154
	Other	1.259	.723	1.000	1.000
Poverty	No	1.235	1.000	1.091	1.000
Urbanicity (Ref. category: Big metro)	Small metro	1.000	.994	1.000	1.000
	No metro	1.000	1.000	.978	1.000
Health insurance	Yes	1.000	.960	.985	1.000
Household (N. memb) (Ref. category: 1)	2	1.000	1.000	1.026	1.000
	3	1.000	.837	1.000	1.000
	4	.960	.787	.932	.989
	5	1.000	.845	.843	1.000
	6+	1.000	.657	.966	1.000
Hous. Instab (Moves) (Ref. category: 0)	1	1.000	1.234	1.099	1.115
	2	1.390	1.241	1.000	1.139
	3+	1.393	1.628	1.268	1.692
Psychological distress	Yes	–	1.690	1.910	9.730
AUD	Yes	1.651	–	3.236	1.454
CUD	Yes	1.859	3.200	–	1.840
SI	Yes	9.338	1.434	1.770	–

Note: For each variable, the OR refers to the considered level compared to the reference category, conditional on all other variables in the network.

Abbreviations: AUD, alcohol use disorder; CUD, cannabis use disorder; Psych distress, psychological distress; SI, suicidal ideation; SDMH, social determinants of mental health; Ref., reference category.

fluctuations in broader social conditions may become visible through increases in cannabis-related problems or psychological distress. In this sense, CUD and psychological distress may serve as early indicators of declining well-being, potentially preceding SI and AUD. Their location within the network

also implies that difficulties in these areas may extend to other interconnected components. From the SDMH perspective, housing instability and employment were the strongest bridges towards psychological factors, while age and sexual orientation emerged as the main bridging nodes within the sociodemographic domain.

With respect to the third objective, a closer examination of individual nodes further clarified how specific sociodemographic and SDMH factors relate to mental health outcomes. Among sociodemographic variables, age emerged as the most central factor. Late adolescence to early adulthood was identified as a high-risk period for mental disorders (Solmi et al., 2022), with psychological distress, CUD and SI showing a gradual decline with age, while AUD peaked between ages 26 and 49 before decreasing. Cannabis use typically begins in adolescence, with addiction developing in young adulthood (Richter et al., 2017; SAMHSA, 2022). On the contrary, alcohol addiction is often less persistent in younger adults, with onset linked to major life transitions (Vergés et al., 2012). These findings underscore the need for targeted interventions during the transition to adulthood, a critical period that influences mental health trajectories. Educational and preventive efforts could mitigate risks by offering coping strategies, support and information to promote healthier outcomes.

Sexual orientation was another critical factor, with sexual minorities showing a higher risk of mental disorders, particularly SI and psychological distress, compared to heterosexual individuals. Specifically, homosexuality was more strongly linked to suicidal thoughts, and bisexuality nearly doubled the risk. Minority stress theory helps explain this increased vulnerability, with stressors like victimization and bullying often contributing to SI (Hatchel et al., 2021; Meyer, 2003). Recent studies have also highlighted the heightened vulnerability of bisexual individuals to psychological distress and SI, driven by stigma and misconceptions about bisexuality as transitory or promiscuous (Feinstein & Dyar, 2017; Nystedt et al., 2019; Salway et al., 2019).

Gender and race showed less prominent associations with the mental health outcomes. In line with previous research, men presented higher rates of SUDs, while women reported higher levels of psychological distress (Drapeau et al., 2012; Madruga et al., 2022). Several hypotheses have been proposed to explain gender disparities in CUD, such as greater liability for externalizing disorders, greater peer use and less perceived stigmatization in men (Hicks et al., 2007; Kramer et al., 2008). Notably, gender was not directly associated with SI. This contrasts with previous research indicating higher SI risk among women (Giugovaz et al., 2024). When modelled together with sexual orientation and other structural factors, gender may no longer be independently associated with SI. This suggests that gender-related differences in suicidality may not operate independently of other intersecting factors. Further research is warranted to clarify the complex interplay between gender, sexual orientation and SI.

Regarding race, Native Americans faced a higher risk for both AUD and CUD compared to White individuals, with the risk for CUD being double. Minority group membership is associated with elevated rates of psychiatric disorders, including anxiety, depression and SUD (Brave Heart et al., 2016). Black and multiracial individuals show an increased risk for CUD too (SAMHSA, 2022). Racial discrimination and race-related stress contribute to cannabis use among Black individuals (Dogan et al., 2021; Zapolski et al., 2020), while multiracial individuals experience high levels of racial discrimination and alcohol use, raising their risk for both CUD and SI (Giugovaz et al., 2024; Nalven et al., 2021). Racial identity invalidation further exacerbates depression and loneliness in multiracial individuals (Franco & O'Brien, 2018), yet research on CUD in this group remains limited. Lastly, Asians exhibited a lower risk for SUD in general (Choi et al., 2024).

Finally, having religious beliefs appeared to act as a protective factor for all the psychological variables. A recent meta-analysis on the relationship between religion and suicidality supports our findings regarding SI (Poorolajal et al., 2022). Religious systems generally discourage violence and suicide, often fostering support networks among community members and restricting high-risk behaviours associated with SI, such as drug and alcohol use. However, a recent scoping review found no specific evidence of the beneficial effects of religiosity and spirituality on substance addiction (Grant Weinandy & Grubbs, 2021). Conflicting results have also been observed concerning the relationship with psychological distress (Eskin et al., 2019).

Regarding the SDMH factors, the strongest bridges were housing instability and employment status. Individuals experiencing housing instability, characterized by frequent relocations within a year, were more likely to suffer psychological difficulties. Previous research has established a link between frequent changes in residence and adverse mental health outcomes, including increased substance use and higher rates of adolescent marijuana initiation (Giugovaz et al., 2024; Glasheen et al., 2017, 2019; Salas-Wright et al., 2019). Frequent relocations can induce significant stress, which is associated with various negative effects on mental health (Cheung & Wong, 2022). Moving often might potentially lead to increased loneliness—a risk factor for psychopathologies such as depression, executive control impairments and even suicide (Hawkey & Cacioppo, 2010).

A distinct pattern emerged regarding employment status: unemployed individuals were at higher risk for psychological distress, CUD and SI, while those with full-time employment showed a greater risk for AUD. This aligns with existing research linking unemployment to increased rates of SI, SUDs and psychological distress (Amiri, 2022; Boden et al., 2017; Nolte-Troha et al., 2023). However, our findings on AUD contrast with previous studies, including Nolte-Troha et al. (2023), which found higher SUD rates among the unemployed. Taken together, these findings suggest that employment does not function uniformly as a protective factor. Full-time employment may expose individuals to specific alcohol-related risks. Such risks may reflect work-related stress, increased income and access to alcohol, social expectations and psychological issues such as burnout.

An interesting finding was the link between household size and a reduced risk of both SUDs. Larger households, whether with family members or roommates, appeared protective against substance dependence. This suggests that everyday social proximity may function as a stabilizing factor within the broader system. Possible mechanisms include increased social monitoring, reduced isolation, family roles and responsibilities and fear of social disapproval. However, living alone does not necessarily imply loneliness or social disconnection, which may explain the lack of association with SI and psychological distress. To our knowledge, the protective role of household size for SUDs has received limited attention in previous research, making this finding particularly noteworthy.

Contrary to expectations, three SDMH factors showed negligible direct effects: poverty was only a mild risk factor for psychological distress, and neither residential area size nor health insurance showed consistent associations. The absent direct link between poverty and SUDs or SI contrasts with prior work (Giugovaz et al., 2024; Manhica et al., 2022) and may reflect overlap with correlated structural and demographic conditions within the broader network. Similar explanations may apply to health insurance and residential area size, alongside measurement limitations: insurance was dichotomized and residential area used just three broad categories, likely obscuring relevant gradients.

Our study shows several strengths. First, it involved a large sample size of over 40,000 individuals, which allowed for a robust and precise network estimation, enhancing the reliability and stability of the results. Second, the sample was representative of the US general population, suggesting that the findings may be reflective of broader societal dynamics and can be seen as indicative of typical trends within the country. Third, the results are likely to be applicable beyond the COVID-19 period, offering valuable insights that remain relevant over time. Lastly, our study lays a strong foundation for exploring important clinical implications, which we discussed in detail later, providing valuable direction for future research and practical applications in the field.

Our study has limitations too. First, given the cross-sectional nature of the data, we could not explore longitudinal relationships among the variables. Future research should investigate the temporal dynamic of the SDMH and sociodemographic factors associated to SUDs, SI and psychological distress over time. Second, SUD symptoms were self-reported rather than clinically assessed, which introduces the risk of biases such as social desirability (Robins et al., 2007). Third, suicidal ideation was self-reported and captured through a single item, which cannot capture its severity, frequency or intent. Multi-item and clinically administered measures would provide a richer characterization of this construct. Fourth, the legal status of cannabis varied across US states during the study period (from recreational legalization to prohibition) but could not be accounted for, as the NSDUH omits all geographic identifiers. This heterogeneity may have influenced cannabis use

patterns, willingness to report and the associations involving CUD. Finally, we did not include some potentially relevant variables like pollution, childhood trauma and family history of substance abuse. Future network studies should incorporate these factors to better understand the associations between SDMH, SUDs, SI and psychological distress.

This study offers important implications. First, clinicians should consider the interactions between psychological factors and the broader environment when developing prevention and treatment plans. In particular, the positioning of CUD and psychological distress at the intersection of sociodemographic and structural domains suggests their potential value as early warning indicators. Individuals presenting with elevated psychological distress and cannabis-related problems may warrant closer monitoring. Beyond these system-level indicators, specific sociodemographic characteristics also emerged as relevant markers of vulnerability. Our analyses highlighted that age and sexual orientation are key sociodemographic factors in individuals with CUD, AUD, psychological distress and SI. While we acknowledge the sensitivity of acquiring sexual orientation data, its significant role in mental health problems underscores the need for its careful integration into clinical assessments and risk evaluations.

Second, policymakers could use these findings to shape more effective mental health policies. Beyond sociodemographic vulnerabilities, the network also emphasized the importance of structural conditions. The strong relationship observed among housing instability, employment status and psychological factors highlights the pressing need to consider the broader social conditions in which many individuals live. These conditions are strongly associated with poorer mental health, which, as previously discussed, often carries a high risk of comorbidity (McGrath et al., 2020). At the same time, the more limited direct connectivity of poverty and health insurance suggests that interventions focused solely on income support or health care access may be insufficient if implemented in isolation. Tackling these challenges demands the creation and enforcement of broad public health and social policies focused on enhancing living conditions, which may in turn improve overall mental health outcomes (Kirkbride et al., 2024).

In conclusion, our study provides a detailed understanding of the complex interrelationships between AUD, CUD, psychological distress, SI and key sociodemographic and SDMH factors. The findings showed that sociodemographic variables, such as age and sexual orientation, served as proximal risk factors for mental health outcomes, while SDMH variables, such as housing instability and employment status, functioned as more distal risk factors, related to mental health primarily through sociodemographic pathways. CUD and psychological distress emerged as key bridging nodes between sociodemographic and SDMH domains and broader mental health factors, reinforcing their potential relevance as early markers within complex vulnerability patterns. Addressing adverse social conditions and integrating strategies to mitigate psychological distress and substance use into prevention and treatment plans could effectively reduce the burden of mental health disorders. This study contributes to existing literature by advancing our understanding of these dynamics and underscores the need for future research to refine intervention strategies and improve outcomes for vulnerable populations.

AUTHOR CONTRIBUTIONS

Angela Giugovaz: Investigation; writing – original draft; methodology; visualization; formal analysis; data curation. **Igor Marchetti:** Conceptualization; supervision; resources; project administration; writing – review and editing; methodology; investigation.

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CONFLICT OF INTEREST STATEMENT

The authors have no relevant financial or non-financial interests to disclose.

DATA AVAILABILITY STATEMENT

This study has been conducted on a public dataset, available in the Substance Abuse and Mental Health Services Administration (SAMHSA) in the National Survey on Drug Use and Health (NSDUH) section (<https://www.samhsa.gov/data/data-we-collect/nsduh-national-survey-drug-use-and-health/datafiles/2021>).

ETHICS STATEMENT

Ethical approval for this secondary analysis of publicly available data was obtained by the Ethics Committee of the University of Trieste, Italy (July 24, 2023).

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the authors used ChatGPT in order to improve the readability and language of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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