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Latent Classes of Substance Use in Young Adults – A Systematic Review

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ABSTRACT

Background: This systematic review provides an overview of studies on latent classes related to the substance use among young adults (18–25 years). Identifying these classes helps to detect high-risk groups, setting a base for selective prevention. **Methods:** This systematic literature review included peer-reviewed studies (published up to February, 2021) that identified latent classes and investigated predictors of latent classes relating to the use of marijuana, alcohol and/or other substances within samples of young adults. **Results:** Twenty studies (sample sizes N=171 to N=21945) met the inclusion criteria. 14 studies identified 'low-level engagers', 'light alcohol and tobacco use', 'heavy alcohol and tobacco use' and 'heavy use/polysubstance use' classes. Four studies differentiated within the 'heavy/polysubstance' class and found 'traditional clubdrugs', 'hallucinogens' and 'wide-range illicit drugs' classes. Male gender and white race predicted membership of the 'heavy use/polysubstance use' class consistently across studies. Other predictors of polysubstance use that were consistent across studies were peer substance use, depressive symptoms, parental drinking and participating in an honor society. **Conclusions:** The investigated predictors of class membership provide insight into social settings and characteristics that predict heavy use or polysubstance use. They can contribute to the development of effective prevention interventions by allowing for a more targeted approach.

KEYWORDS

Young adult; classes; profile; substance; polydrug

1. Introduction

The current systematic review aims to identify groups of young adults in the general population who are at increased risk for developing harmful use of substances, such as marijuana, ecstasy, amphetamines or cocaine, or for developing substance use disorders, which may have serious adverse health consequences.

The use of substances is associated with a wide range of risks, e.g. poor mental health, physical risks, dependence, and elevated mortality in general (Farrell et al., 2019; Hall et al., 2019; Ryan et al., 2019; Zimmermann et al., 2020). Yet, drug use is prevalent among a considerable group of young people in the Western world (Coomber et al., 2016; Moyle & Coomber, 2019). In the general European population, 15% of the group aged 15–34 are estimated to have used marijuana in the last year, 1.9% used ecstasy the previous year and 2.4% used cocaine (EMCDDA, 2019). The risk of developing substance use disorders varies with type of drug, frequency or pattern of use, social setting in which drugs are used and characteristics of the person who uses drugs (EMCDDA, 2019; Hartogsohn, 2017; Zinnberg, 1986). High risk groups may include: people who have prior experience with illegal drugs, people with mental health problems, or people in social settings in which drug use is highly prevalent (Connor et al., 2014; EMCDDA, 2019; Hartogsohn, 2017; Zinnberg, 1986). For example, young adults raised in families characterized by a high addiction rates across generations, will be

at a greater risk of developing substance use disorders themselves (Webster, 2017; Zimić & Jukić, 2012).

The primary objective of substance use prevention is to help people avoid or delay the initiation of substance use and to avert the development of harmful substance use or substance use disorders after initiation (UNODC & WHO, 2018). Studies have found that in substance use prevention, selective and indicated approaches elicit larger effects compared to universal approaches (Chen et al., 2014; Compton et al., 2019; Conrod, 2016; Edalati & Conrod, 2018; Farrell et al., 2019; Fischer et al., 2017; Fuller et al., 2001; Onrust et al., 2016). Prevention interventions are most effective when groups who are at a higher risk of using drugs or of developing harmful substance use patterns or substance use disorders are targeted (Edalati & Conrod, 2018; Farrell et al., 2019). Targeting involves development of a single intervention approach for a defined population subgroup that takes into account characteristics shared by the subgroup's members (Kreuter & Skinner, 2000). It leads to an increased relevance of this intervention for the target group, which in turn may lead to more effective interventions at a lower cost (Collins et al., 2004).

A targeted approach is especially relevant for young adults, who are in a critical transitional period from childhood to adulthood (Stockings et al., 2016). For most substances, the general starting age lies between 18 and 25 (Arria et al., 2017; Darvishzadeh et al., 2019; Reid et al., 2008; United Nations Office on Drugs & Crime, 2019).

Therefore, the age group 18-25 is particularly relevant in terms of prevention of substance use. Not only is drug use most prevalent in this age group (Degenhardt et al., 2019; Johnston et al., 2016), these young adults are also more difficult to reach with family- or school-based prevention efforts than a younger age group, because at the age of 18 or 19, they often move out of the family home (SAMHSA's Center for the Application of Prevention Technologies, 2015).

In order to develop a targeted prevention approach for young adults, it is necessary to better understand their drug use behaviors and associated risk factors. Identification of profiles regarding substance use may be useful and provides some clear advantages over the use of frequencies and quantities without taking typologies of use into account. First, identification of different user profiles may enable a better understanding of possible underlying factors of types of substance use. Motivations for substance use can be indicative over patterns of substance use as well as frequency of use (Cooper et al., 1995; Cox & Klinger, 2004; Lee et al., 2009). Second, classification of user profiles may enable the tailoring of intervention efforts specifically targeting those risk factors most common among different subtypes of young adult substance users. Indeed, given the diversity of experiences in substance use by young adults, person-centered approaches have been advocated as necessary to more fully capture the complex links between risk factors and substance use outcomes (Ludden & Eccles, 2007). A particularly suitable person-centered approach for analyzing subtypes of young adults based on drug use behavior is latent class analysis (LCA) (Sutherland et al., 2018; Tomczyk et al., 2016), which enables researchers to identify replicable latent groups in the population (Finch & Pierson, 2011; Tomczyk et al., 2016). LCA can provide an enhanced understanding of quantitative and qualitative group differences in substance use and predictors of group membership, thus making a targeted approach attainable.

Identifying subgroups based on drug use behavior, as well as predictors in the development of harmful substance use or substance use disorders, can allow us to detect high-risk groups, setting a base for selective or indicated prevention. Yet, no empirical review has been conducted covering studies on latent classes of substance use in young adults (18-25 years). The only previously published systematic review on classes of adolescents who use drugs covered ages 10 to 19 and not ages 19 to 25 (Tomczyk et al., 2016). This seems a lacuna in the current literature. The purpose of this review is to analyze studies on latent classes of substance use, in order to find young adults in the general population who are at increased risk for developing harmful substance use. The analysis will focus on studies that include (illegal) substances such as marijuana, ecstasy, amphetamines or cocaine as indicators for classes. Those illegal substances have a different legal status, accessibility, type of risks, perceived harmfulness and prevalence than alcohol and tobacco. As a result, at-risk groups and the required prevention approach for these substances are possibly different. Classes based on alcohol and tobacco are expected have a different structure and meaning as well. Studies that focus solely on alcohol and or tobacco will therefore not be included.

2. Material and methods

2.1. Procedure

This systematic review was conducted in accordance with the PRISMA Statement (Moher et al., 2015).

2.2. Search strategy

A search in the PsycINFO (via Ovid), CINAHL (via EBSCOhost), Academic Search Premier (via EBSCOhost) and MEDLINE (via Ovid) publication databases was performed, and articles published up to February 2021 were included. To identify relevant articles, the following keywords were combined through Boolean search: (latent class OR latent profile) AND (substance OR drug OR polydrug OR polysubstance OR hallucinogen OR cocaine OR marijuana OR amphetamine OR ecstasy) AND (student* OR adolesc* OR youth OR young adult OR emerging adult). Search terms were applied to abstracts, keywords and titles. The search was limited to studies in English, published in peer-reviewed journals.

2.3. Eligibility criteria

Eligibility criteria were as follows:

- The study identified latent classes relating to the use of marijuana and/or other illegal substances (e.g., ecstasy, amphetamines, cocaine). Studies that used alcohol- or tobacco-related indicators were only included if they also used at least one indicator related to the use of marijuana and/or other illegal substances.
- Studies were excluded if variables other than those reflecting aspects of substance use were used as indicators (outcome variable) of latent classes (e.g., sexual behavior, exposure to violence), as this would alter the meaning and structure of resulting classes.
- Only studies using samples with a mean age between 18 and 25 years were included.
- Studies were included if they used latent class analysis (LCA), latent profile analysis (LPA) or latent transition analysis (LTA). In the case of a LTA, the results of latent classes at baseline were extracted. Studies employing latent class growth analysis or latent trajectory analysis were not included because of the focus on developmental trajectories or changes over time in the use of substance(s), instead of a focus on identifying classes based on different substance use aspects.
- Studies were excluded if variables reflecting genetic, physiological or biological aspects of substance use were used as indicators of latent classes.
- Study samples were commensurable with a general population of young adults. Studies using samples selected based on the prior use of a specific drug (e.g., ecstasy, hallucinogens, cocaine), samples of

young adults in treatment for a serious mental illness or addiction and samples consisting of juvenile offenders were excluded.

2.4. Study selection

The search initially returned 2315 hits, of which 1284 were duplicates. The resulting 1031 studies were submitted to the eligibility criteria. Titles and abstracts of these studies were exported to Microsoft Excel and evaluated separately by the first author and at least one other reviewer: LL, MK or a research assistant. All studies that possibly met the eligibility

criteria were obtained in full text and assessed for inclusion. The few inconsistencies were discussed and resolved. As shown in Figure 1, 18 studies met the inclusion criteria. An ancestor search identified two additional studies, resulting in the inclusion of 20 studies.

2.5. Data collection and analysis

The following information was extracted from the studies and collected in a summary table: author(s), publication year, country, sample characteristics, indicators variables used in modeling the latent classes, number, nature and size

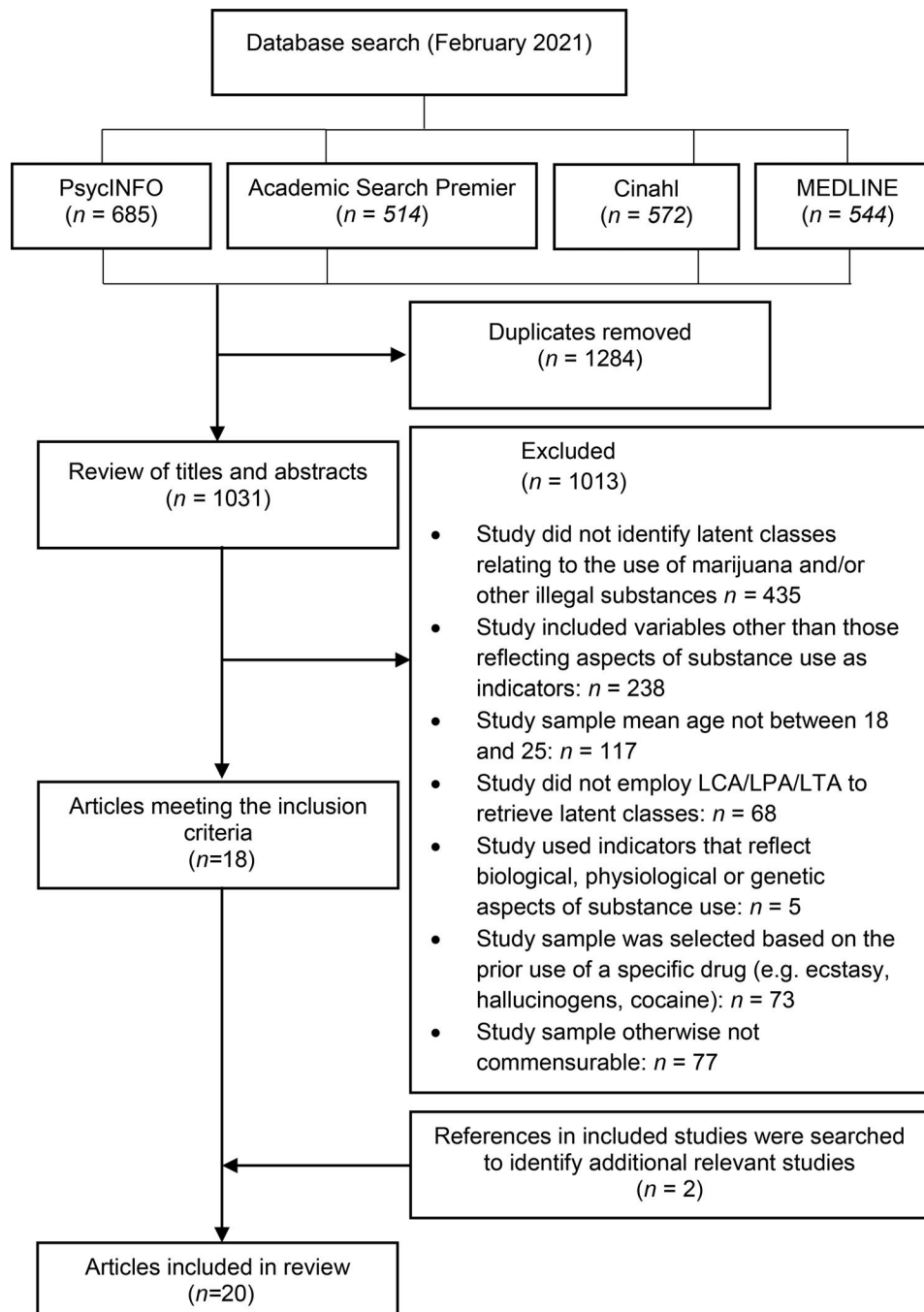


Figure 1. Database search and selection of studies.

of identified classes, investigated predictors and statistical significance of predictors.

2.6. Risk of bias and quality assessment

Risk of bias was evaluated using an adapted form of the Newcastle Ottawa scale for LCA studies (Tomczyk et al., 2016). This tool consists of eight items including quality aspects of selection, comparability and outcome. Items were scored with 0-2 points and summed up to a maximum score of 10 points. Summed scores were grouped into high (0-6), moderate (7-8), and low (9-10) risk of bias.

3. Results

3.1. Sample and setting

A total of 20 studies were included in the current review (see Table 1 and Figure 1). These articles were published between 2013 and 2020 in 14 different peer-reviewed journals. Eleven studies were conducted in the United States, four in Australia and two in Germany. Other studies were conducted in Iran, Brazil and Denmark. Nine studies recruited from a nationally representative sample, others used a sample of students or patrons of nightclubs. Sample sizes ranged from 171 (Cadigan et al., 2019) to 21,941 (Chiauzzi et al., 2013) and the percentage of female participants varied from 38.4% (Hannemann et al., 2017) to 65.6% (Choi et al., 2020). Three studies offered separate LCA for male and female participants (Armour et al., 2014; Snyder & Merritt, 2015; Snyder & Rubenstein, 2014). Mean age of study participants ranged from 18.06 years (Choi et al., 2020) to 24.4 years (Fernández-Calderón et al., 2018).

3.2. Risk of bias

Risk of bias criteria and scores can be found in the additional materials, summed scores were added to Table 1. Five studies had a low risk of bias, 11 studies had a moderate risk of bias and four studies had a high risk of bias. A higher risk of bias was typically the result of samples not being representative of the average in the target population of that study. Studies varied greatly in which substance(s) were used as indicators, operationalization of substance use (e.g., lifetime use, past year/month use, hazardous use), sample size (N=171 to N=21945), sample characteristics and examined predictors.

3.3. Substance use indicators

All 20 studies used frequency or pattern of use of one or more specific substances as indicators to model classes. The indicator variables (see Table 1) were typically lifetime use or use in the previous year or month. All studies but one (Chan et al., 2019) included frequency of marijuana use as indicator, 14 studies used frequency of use of other drugs, 16 studies included frequency of alcohol use and

11 studies included frequency of tobacco use. Nine studies included multiple alcohol-related indicators, like binge drinking and risk behavior while under the influence of alcohol.

3.4. Latent classes

Of the 20 included studies, 14 studies identified three or four classes based on participants' frequency of substance use, ranging from low level of substance use to heavy use/polysubstance use (Arterberry et al., 2017; Cadigan et al., 2019; Chan et al., 2019, 2020; Chiauzzi et al., 2013; Choi et al., 2018, 2020; Haas et al., 2015; Kelly et al., 2014; Lanza et al., 2014; Quek et al., 2013; Sañudo et al., 2015; Snyder & Merritt, 2015; Snyder & Rubenstein, 2014; Tomczyk et al., 2016). These studies all included one or more alcohol-related outcome variables, which has led to a class structure that is mainly based on the frequency of alcohol use, as shown in paragraphs 3.4.1 to 3.4.4. The six remaining studies that deviated from that pattern are described under '3.5 latent classes of clubdrugs' and '3.6 hookah related classes'. Class proportions for each study can be found in Table 1.

3.4.1. Low-level engagers

This class showed a low probability for alcohol and tobacco use, and a (very) low probability for marijuana use. This class was identified in seven studies (Arterberry et al., 2017; Cadigan et al., 2019; Chiauzzi et al., 2013; Choi et al., 2018; Haas et al., 2015; Lanza et al., 2014; Tomczyk et al., 2016). 'Low-level engagers' were the second-largest class in most studies, with the combined alcohol-oriented classes (3.4.3) being the largest. Class proportions ranged from 34.7% (Lanza et al., 2014) to 46% (Chiauzzi et al., 2013) with one exception: one study found low-level engager classes of respectively 26% and 9% (Cadigan et al., 2019), using a sample of 2-year college students and a sample of 4-year college students. The difference between this study and the others possibly lies in the sample characteristics: Cadigan et al. (2019) used a sample of college students with a mean age of 20 years, while the other studies used samples of college students with a mean age of 18 or 19 years (Arterberry et al., 2017; Chiauzzi et al., 2013; Choi et al., 2018; Haas et al., 2015; Tomczyk et al., 2016) or a population based sample (Lanza et al., 2014).

3.4.2. Light alcohol and tobacco use

The 'light alcohol and tobacco use' class had a moderate to high probability for alcohol use, a moderate to high probability for tobacco use and a low probability for binge drinking and other substances. This class was identified in 12 studies (Arterberry et al., 2017; Cadigan et al., 2019; Chan et al., 2020; Chiauzzi et al., 2013; Choi et al., 2020; Kelly et al., 2014; Lanza et al., 2014; Quek et al., 2013; Sañudo et al., 2015; Snyder & Merritt, 2015; Snyder & Rubenstein,

Table 1. Overview of studies included in the review.

Study	Country ^a	Sample characteristics	Indicator variables	Number, nature and size of identified classes	Investigated covariates *statistically significant covariates	Risk of Bias score ^b
(Armour et al., 2014)	DK	N = 2980 Randomly sampled from Danish 1984 birth cohort 47.8 % female Age: 24 <i>Separate LCA for male and female respondents</i>	marijuana use (lifetime) ecstasy use (lifetime) amphetamines use (lifetime) cocaine use (lifetime) LSDj use (lifetime) mushrooms use (lifetime) heroin use (lifetime) amyl nitrate (sniff) use (lifetime)	<i>Female:</i> 1: marijuana only or no drugs (90.6%) 2: amphetamine, marijuana, cocaine, and amyl nitrate polydrug (7.3%) 3: wide-range polydrug use (2.2%) <i>Male:</i> 1: marijuana only or no drugs (74.4%) 2: amphetamine, marijuana, cocaine, and amyl nitrate polydrug use (18.1%) 3: wide-range polydrug use (7.5%)	<i>Female:</i> • Demographics: • Living conditions* • Identified child-protection case status • Self-reported mental disorder • *Current or past alcohol problems • Lifetime drug use • Childhood maltreatment (*sexual, physical, emotional abuse and neglect). <i>Male:</i> • Demographics: • Living conditions* • Identified child-protection case status • *Self-reported mental disorder • *Current or past alcohol problems • Lifetime drug use • Childhood maltreatment (sexual,*physical, emotional abuse and neglect). • *Risk perception of driving after alcohol or marijuana use • *Likelihood of experiencing consequences of driving while intoxicated (marijuana) • Likelihood of experiencing consequences of driving while intoxicated (alcohol)	8
(Arterberry et al., 2017)	US	N = 897 Young adults in college 54.7% female Age: M = 19.01 SD = 1.88	alcohol use (P12M and PM freq) marijuana use (P12M and PM freq) marijuana use (quantity in a typical week) alcohol use (quantity on a typical day) binge drinking ^c (PM) SAM ^d (PM) driving within 2 hours of binge drinking and/or marijuana use (PM)	1: Low-level engagers (35.5%) 2: Alcohol-centric engagers (41.2%) 3: Concurrent engagers (15.9%) 4: Marijuana-centric/simultaneous engagers (7.4%)	Demographics: *Age, gender	7
(Cadigan et al., 2019)	US	Sample 1: N = 171 2-year college students 49.7% female Age: M = 20.31 SD = 1.66 Sample 2: N = 355 4-year college students 57.2% female Age: M = 20.1 SD = 1.56	alcohol use (PM) marijuana use (PM) binge drinking (PM) estimated peak BAC ^e (PM) alcohol related problems (Brief Young Adult Alcohol Consequences Questionnaire (PM) SAM (PM)	Sample 1: 1: Non-users (26%) 2: Light-drinking-only class (39%) 3: Heavy drinking/heavy marijuana/SAM use class (27%) 4: Light drinking/heavy marijuana class (8%) Sample 2: 1: Non-users (9%) 2: Light-drinking-only class (26%) 3: Heavy drinking/light marijuana/SAM use class (32%) 4: Heavy-drinking-only class (33%)	Demographics: Age,*gender	

continued

Table 1. Continued

Author	Study	Sample	Wave	Amphetamine use (lifetime)	Amphetamine use (P12M)	Demographics:	8
(Chan et al., 2019)	Waves 7 and 8 of the Victoria Adolescent Health Cohort Study	N = 1755 53% female Age: M = 15.5 (wave 2) – 35.1 (wave 10)	Wave 6: Wave 7: Wave 8: Wave 9: Wave 10:	Amphetamine use (lifetime) Amphetamine use (P12M) Amphetamine use (P30D freq) Amphetamine use (P12M) Amphetamine use (P30D freq)	1: Non-user: no amphetamine use (84.1%) 2: Occasional user (14.5%) 3: Regular user (1.8%)	*gender*Anti-social behavior (self-report early delinquency scale) *Symptoms of depression and anxiety (CIS-R) Binge drinking (PW) Tobacco use (no use, daily, less) *Cannabis use (no use, weekly, less) Peer alcohol use *Peer tobacco use	8
(Chan et al., 2020)	2004-2016 National Drug Strategy Household Survey	N = 20350 58% female Age: M = 24.5	Wave 6: Wave 7: Wave 8: Wave 9: Wave 10:	Amphetamine use (P12M) Amphetamine use (P30D freq) Amphetamine use (P12M) Amphetamine use (P30D freq) Amphetamine use (P12M) Amphetamine use (P30D freq) Amphetamine use (P12M) Amphetamine use (P30D freq) alcohol use (P12M freq) tobacco use (P12M freq) marijuana use (P12M) ecstasy use (P12M) tranquillizer or sleeping pills use (P12M) cocaine use (P12M) hallucinogen use (P12M) meth or amphetamine use (P12M) ketamine use (P12M) heroin use (P12M) alcohol use (quantity in a typical week) binge drinking (P2W) marijuana use (P12M freq) cocaine use (P12M freq) methamphetamine use (P12M freq) hallucinogens use (P12M freq) heroin use (P12M freq) inhalants use (P12M freq) designer drugs use (P12M freq) steroid use (P12M freq) NMUPMh use (P12M freq)	1: Minimal users (60%) 2: Mainly tobacco, alcohol and cannabis users (30%) 3: Extended polysubstance users (10%)	Demographics: *Age,*gender,*high school completion, *sexual preference,*income level, socio-economic status of area,*remoteness of area, *spoken language at home*Psychological distress *General health	8
(Chiauzzi et al., 2013)	First year college students	N = 21945 55.6% female Age: M = 18.3 SD = 0.9	Wave 6: Wave 7: Wave 8: Wave 9: Wave 10:	Amphetamine use (P12M) Amphetamine use (P30D freq) Amphetamine use (P12M) Amphetamine use (P30D freq) Amphetamine use (P12M) Amphetamine use (P30D freq) alcohol use (quantity in a typical week) binge drinking (P2W) marijuana use (P12M freq) cocaine use (P12M freq) methamphetamine use (P12M freq) hallucinogens use (P12M freq) heroin use (P12M freq) inhalants use (P12M freq) designer drugs use (P12M freq) steroid use (P12M freq) NMUPMh use (P12M freq) BAC (P2W) DUJ/RWDD ^f (lifetime) experienced negative effects of alcohol exhibited negative behaviors after consuming alcohol alcohol use (P12M) tobacco use (P12M) marijuana use (P12M) cocaine, amphetamines, inhalants, over counter the cold or cough medicine with the intent of getting high or ecstasy use (P12M)	1: Low risk for alcohol and a low prevalence for drug use (46.0%) 2: Lower intake for alcohol and moderate prevalence for drug use (20.2%) 3: Moderate risk for alcohol drinking and moderate prevalence for drug use (13.6%) 4: High risk for alcohol drinking and a high prevalence for drug use (20.2%)	Demographics: *Age,*gender,*race/ethnicity *Social norms awareness perceived harmfulness of illegal drugs and NMUPM, *Protective behaviors (personal and toward peers)	8
(Choi et al., 2018)	Wave 4 of the Texas Dating it Safe study (high school students)	N = 354 2013 55.9% female Age: M = 19.1 SD = 0.79	Wave 6: Wave 7: Wave 8: Wave 9: Wave 10:	Amphetamine use (P12M) Amphetamine use (P30D freq) Amphetamine use (P12M) Amphetamine use (P30D freq) Amphetamine use (P12M) Amphetamine use (P30D freq) alcohol use (P12M) tobacco use (P12M) marijuana use (P12M) cocaine, amphetamines, inhalants, over counter the cold or cough medicine with the intent of getting high or ecstasy use (P12M)	1: Mild alcohol use (36%) 2: Alcohol and moderate marijuana use (44.4%) 3: Polysubstance Use (19.6%)	Demographics: *Gender	6

(Choi et al., 2020)	US	N = 698 2014 Wave 5 of the Texas Dating it Safe study (high school students) 65.6% female Age: M = 18.06 SD = 0.79	alcohol use (P12M and PM) binge drinking (PM) tobacco use (P12M) marijuana use (P12M and PM) prescription medication (P12M and PM) cocaine, amphetamines, inhalants, hallucinogen or ecstasy use (P12M) extreme heavy episodic drinking (+8/+10 (f/m) drinks within 24 hours) (P12M) tobacco or chew/snuff/dip use (P30D) hookah use (P12M) marijuana use (P12M) NMIUPMe use (P12M)	1: Mild alcohol use (38.1%) 2: Regular Alcohol Use (25.7%) 3: Occasional alcohol and marijuana use (8.7%) 4: Heavy alcohol and marijuana use (20.9%) 5: Polysubstance Use (6.6%)	Demographics: Age, gender, race/ethnicity, *parents highest education *Dating violence perpetration *Dating violence victimization	8
(Evans-Polce et al., 2018)	US	N = 608 4 th year college students 51% female Age: M = 21.5 SD = 0.4	1: Non/low users (61.8%) 2: Non-hookah tobacco users (6.8%) 3: Extreme HEDc & marijuana users (12.0%) 4: Hookah & marijuana users (13.7%) 5: Poly-substance users (5.6%)	Demographics: Age, *gender, Current Grade Point Average (GPA) *Honors society involvement Academic prof. organization involvement *Sports involvement *Greek involvement *Time spent partying (hours/average day) Time spent doing school work (hours/average day)	8	
(Fernández-Calderón et al., 2018)	US	N = 1045 Individuals entering electronic dance music parties 47% female Age: M = 24.4 SD = 4.9	marijuana use (P12M) ecstasy use (P12M) speed use (P12M) cocaine use (P12M) LSD use (P12M) magic mushrooms use (P12M) ketamine use (P12M) benzodiazepines (P12M)	1: no polysubstance use (61.1%) 2: extensive polysubstance use (19.2%) 3: moderate polysubstance use (12.8%) 4: moderate polysubstance use/psychedelics (6.7%)	Demographics: Age, gender, *race/ethnicity, education, parent income, *weekly income, sexual orientation Past year use of NPSg *2 C series *Bath Salts (synthetic cathinone) *Tryptamines *New other psychedelics *Synthetic cannabinoids	8
(Haas et al., 2015)	US	N = 772 Entering college freshmen with prior alcohol use 53% female Age: M = 18.07 SD = 0.36	alcohol use (P30D) binge drinking (P2W) marijuana use (P30D) age of onset marijuana use SAM use Continuous measure of recent alcohol involvement (typical quantity x number of days)	1: light drinking with no recent marijuana use (40%) 2: moderate drinking with no recent marijuana use (25%) 3: moderate drinking with recent marijuana use (22%) 4: heavy drinking with recent marijuana use (14%)	Demographics: Age, *gender, *race/ethnicity *Greek affiliation *Motivations associated with substance use (Behavioral Inhibition/ Behavioral Activation Scales (BIS/BAS)) *Alcohol expectancy Inventory *Age of initiation (alcohol) *Risky drinking behavior *Alcohol related problems *Blackout episode Overdosed *Physical injury *Legal problems *Intoxicated driving *Risky sexual behavior *Percentage of drinking events involving pregameing and drinking games	8

continued

Table 1. Continued

(Hannemann et al., 2017)	DE	N=3571 Patron of electronic dance music events 38.4% female Age: M=24.1 SD=4.7	marijuana use (P12M) ecstasy use (P12M) speed use (P12M) cocaine use (P12M) LSD use (P12M) magic mushrooms use (P12M) ketamine use (P12M) GHB/GBL use (P12M) heroin use (P12M) crystal methamphetamine use (P12M) NPS use (P12M) medicines and natural drugs (e.g., salvia divinorum, kratom, ayahuasca) use (P12M) tobacco use (lifetime) tobacco use (PW freq) hookah use (lifetime) hookah use (PW freq) alcohol use (lifetime) alcohol use (PM) illicit drugs (Ritalin, methamphetamine, ecstasy, marijuana, opium, heroin) use (lifetime)	1: The conservative class (34.9%) 2: The traditional class (36.6%) such as marijuana, speed, ecstasy and LSD. 3: The psychedelics class (17.5%) 4: The unselective class (10.9%)	Demographics: Age,*gender*Past 30-day frequency of marijuana, ecstasy, speed, cocaine, heroin, crystal methamphetamine, LSD, magic mushrooms, ketamine, GHB/GBL, NPS, medicines and natural drugs (e.g., salvia divinorum, kratom, ayahuasca) use *Lifetime use of two or more substances at one time (combination use)	6
(Kabir et al., 2018)	IR	N=5252 University freshman 62.9% female Age: M=20.6 SD=9.4	tobacco use (lifetime) tobacco use (PW freq) hookah use (lifetime) hookah use (PW freq) alcohol use (lifetime) alcohol use (PM) illicit drugs (Ritalin, methamphetamine, ecstasy, marijuana, opium, heroin) use (lifetime)	1: Healthy class (82.8%) 2: Hookah-experimenters (16.1%) 3: Unhealthy class (2.1%)	Demographics: *Age,*gender, marital status, residence status*Having a family member who smoked *Having a close friend who smoked	6
(Kelly et al., 2014)	AU	N=3836 2010 National Drug Strategy Household Survey (NDSHS) 57.7% female Age: Range = 18-29 M=24	alcohol use (P12M) tobacco use (P12M) marijuana use (P12M) ecstasy use (P12M) tranquillizer or sleeping pills use (P12M) cocaine use (P12M) hallucinogen use (P12M) meth or amphetamine use (P12M) NMUPM use (P12M)	1: Past year use of alcohol only (50.9%) 2: Alcohol and tobacco (36.6%) 3: Marijuana, ecstasy and other licit drug use (10.2%) 4: Extended concurrent drug use (2.3%)	Demographics: Age,*gender,* couple relationship status,*high school completion,*income levels,*language spoken at home, remoteness of area*Depressive symptoms measured by the Kessler 10 scale.	7
(Lanza et al., 2014)	US	N=15,119 Wave III of the National Longitudinal Study of Adolescent Health Add Health Dataset 53 % female Age: M=22.47 SD=1.16	tobacco use (lifetime) tobacco use (P30D freq) alcohol use (P12M) binge drinking (P12M) alcohol use (P7Y) DUI (P7Y) being drunk, having a hangover, or drinking +5 drinks (P2W) marijuana use (P7Y) marijuana use (P12M) marijuana use (P30D)	1: Low substance use (34.7%) 2: Regular smokers (12%) 3: High-risk alcohol use (33%) 4: High substance use (20%)	Demographics: *Gender,*race/ethnicity,* mothers educational attainment*Overweight/obesity indicator based on body mass index, age and gender	9

(Quek et al., 2013)	AU	<p>N = 3,011 2007 National Drug Strategy Household Survey (NDSHS) 57.8 % female Age: M = 23.78 SD = 3.42</p>	<p>tobacco use (P12M) alcohol use (P12M) marijuana use (P12M) cocaine use (P12M) ecstasy use (P12M) meth/amphetamine use (P12M) pain killer use (P12M) tranquillizers/sleeping pills use (P12M) hallucinogens use (P12M)</p>	<p>1: Alcohol only (52.3%) 2: Alcohol and tobacco (34.18%) 3: Cannabis, ecstasy and illicit drugs (9.44%) 4: Cannabis, amphetamine derivatives and illicit drugs (2.79%) 5: Sedatives and alcohol (1.3%)</p>	<p>Demographics: *Age,*gender,*high school completion,*marital status, employment status,*income level, socio-economic status of area, remoteness of area *Depressive symptoms measured by the Kessler 10 scale. *General health *Peer alcohol use *Peer tobacco use *Peer marijuana use</p>	8
(Sañudo et al., 2015)	BR	<p>N = 2420 Patrons of nightclubs in Sao Paulo 39.2% female Age: Range: 18-25 (62.9%) 26-33 (24.9%) >33 (12.3)</p>	<p>tobacco use (P12M) marijuana use (P12M) cocaine use (P12M) ecstasy use (P12M) inhalant use (P12M) ketamine use (P12M) hallucinogens use (P12M) binge-drinking (P12M) being drunk (P12M) binge drinking (P12M) marijuana use (P7Y) cocaine, crystal meth, sedatives or downers, tranquilizers, stimulants or painkillers use (P7Y)</p>	<p>1: No polydrug use (55%) 2: Moderate polydrug use (35%) 3: High level polydrug use (10%)</p>	<p>Demographics: *Age,*gender, race/ethnicity , socio-economic status, marital status, educational attainment, occupation and religion*Frequency of attending nightclubs in the last 30 days Type of nightclub, classified by the musical style</p>	9
(Snyder & Merritt, 2015)	US	<p>N = 11,158 Wave III of the National Longitudinal Study of Adolescent Health Add Health Dataset 49.6 % female Age: M = 21.5 SD = 0.03 Separate LCA for male and female respondents</p>	<p>binge drinking (P12M) marijuana use (P7Y) cocaine, crystal meth, sedatives or downers, tranquilizers, stimulants or painkillers use (P7Y)</p>	<p>Female: 1: Low-use substance use patterns (48.9%) 2: Alcohol and marijuana (31.2%) 3: Moderate polysubstance use (11.2%) 4: Heavy polysubstance use (8.7%)</p> <p>Male: 1: Low-use substance use patterns (16.9%) 2: Alcohol and marijuana (56.2%) 3: Moderate polysubstance use (15.4%) 4: Heavy polysubstance use (11.4%)</p>	<p>Female: Demographics: Age,*race/ethnicity , *educational attainment,*relationship status,*living situation*Parental drinking (consumed 5+ alcoholic drinks on one occasion in the past month) *Depression measured by the Center for Epidemiologic Studies Depression Scale (CES-D) *Severe supervisory neglect (By the time you started 6th grade, how often had your parents or other adult caregivers left you home alone when an adult should have been with you?) *Mean adolescent delinquency (based on 15 items measuring delinquency)</p> <p>Male: Demographics: *Age,*race/ethnicity *educational attainment,*relationship status, living situation*Parental drinking (consumed 5+ alcoholic drinks on one occasion in the past month) *Depression measured by the CES-D *Severe supervisory neglect (By the time you started 6th grade, how often had your parents or other adult caregivers left you home alone when an adult should have been with you?) *Mean adolescent delinquency (based on 15 items measuring delinquency)</p>	10

continued

Table 1. Continued

Snyder & Rubenstein, 2014)	US	N = 11,546 Wave III of the National Longitudinal Study of Adolescent Health Add Health Dataset 53.2% female Age: M = 21.67 SD = 0.04 <i>Separate LCA for male and female respondents</i>	tobacco use (lifetime) regular tobacco use (lifetime) alcohol use (P12M) binge drinking (P12M) marijuana use (P7Y) cocaine (incl. crack, freebase, powder) use (P7Y) other drugs use (P7Y) being drunk, having a hangover, or drinking +5 drinks (P2W) drunk at school or work (P12M) school or work problems because of drinking alcohol (P12M) problems with friends related to the respondent's alcohol use (P12M) problems with dating related to respondent's alcohol use (P12M) regretted sex because of alcohol use (lifetime)	Female: 1: Normative (44.3%) 2: Moderate use (40.2%) 3: Heavy use (15.6%) Male: 1: Normative (33.5%) 2: Moderate use (44.8%) 3: Heavy use (21.8%)	Female: Demographics: *Age,*race/ethnicity,*educational attainment,*relationship status,*living situation*Incest victim *Parental drinking (consumed 5+ alcoholic drinks on one occasion in the past month) *Depression measured by the CES-D Male: Demographics: Age,*race/ethnicity, educational attainment,*relationship status,*living situationIncest victim *Parental drinking (consumed 5+ alcoholic drinks on one occasion in the past month) *Depression measured by the CES-D	10
(Tomczyk et al., 2016)	DE	N = 5214 Students from vocational schools 46% female Age: M = 19.39 SD = 3.92	DUI (lifetime) alcohol use (PM) tobacco use (PM) marijuana use (PM) Problematic alcohol use (Brief Alcohol Screening Instrument for Medical Care (BASIC)) Problematic marijuana use (Severity of Dependence Scale (SDS))	1: Low use (43%) 2: Mainly alcohol use (50%) 3: Polysubstance use (7%)	Demographics: Age, gender and pre-vocational education attainmentDepressive symptoms (depression subscale of the Brief Symptom Inventory) Job demands/demanding characteristics *Job stress (seven items from the Copenhagen Psychosocial Questionnaire) Job satisfaction (vocational education, workplace, and employment)	9

PM = past month, PW = past week, P7Y = past 7 years, P12M = past 12 months, etc.

Unless frequency is noted, indicator variables are measuring binary use.

*Statistically significant covariates.

^aDK = Denmark, US = United States, AU = Australia, DE = Germany, IR = Iran, BR = Brazil.

^bIndividual risk of bias per study overall range: 0-10 (Selection 0-5, Comparability 0-2, Outcome 0-3). Also see additional materials.

^cBinge drinking = Heavy Episodic Drinking (HED): more than 4/5 (women/men) drinks at one occasion.

^dSAM = simultaneous alcohol and marijuana use.

^eBAC = Blood-alcohol concentration: based on sex, weight, number of drinks consumed, and number of hours consuming alcohol.

^fDUI/RWDD = Driving under influence/riding with drinking driver.

^gNPS = new psychoactive substances.

^hNMUPM = Nonmedical Use of Prescription Medication

ⁱLSD = lysergic acid diethylamide.

2014). The ‘light’ class proportions ranged from 12% (Lanza et al., 2014) to 60% (Chan et al., 2020).

3.4.3. Heavy alcohol and tobacco use

The ‘heavy alcohol and tobacco use’ class represented a moderate to high probability for alcohol use, tobacco use, binge drinking and alcohol related problems. It also had a low to moderate probability for marijuana use and a very low probability for the use of other illegal drugs. This class was identified in nine studies (Arterberry et al., 2017; Cadigan et al., 2019; Chan et al., 2020; Chiauzzi et al., 2013; Choi et al., 2020; Haas et al., 2015; Lanza et al., 2014; Quek et al., 2013; Sañudo et al., 2015). Class proportions ranged from 13.6% (Chiauzzi et al., 2013) to 35% (Sañudo et al., 2015).

Five studies identified a combined ‘alcohol and tobacco use’ class, including both the light and the heavy alcohol and tobacco use classes, with moderate to high probabilities for alcohol use and low to moderate probabilities for marijuana use (Choi et al., 2018; Kelly et al., 2014; Snyder & Merritt, 2015; Snyder & Rubenstein, 2014; Tomczyk et al., 2016). These combined alcohol-oriented classes were the largest class in most of the included studies, with class proportions between 33% (Chiauzzi et al., 2013) and 66% (Cadigan et al., 2019). One study (Quek et al., 2013) described an ‘alcohol-only’ class and an ‘alcohol and tobacco’ class, thus not distinguishing between light or heavy use of alcohol. This class represented 86.48% of the study sample.

3.4.4. Heavy use/polysubstance use

The ‘heavy use/polysubstance use’ class had the highest probabilities of alcohol use and binge drinking and moderate to high probabilities for the use of illegal substances. It was the smallest class and identified in all 14 studies that used alcohol-related indicators (Arterberry et al., 2017; Cadigan et al., 2019; Chan et al., 2020; Chiauzzi et al., 2013; Choi et al., 2018, 2020; Haas et al., 2015; Kelly et al., 2014; Lanza et al., 2014; Quek et al., 2013; Sañudo et al., 2015; Snyder & Merritt, 2015; Snyder & Rubenstein, 2014; Tomczyk et al., 2016). Three of these studies described more than one polysubstance use class. One study distinguished between ‘heavy’ and ‘moderate polysubstance use’ (Snyder & Merritt, 2015), one study between an ‘alcohol, marijuana, and ecstasy’ class and an ‘other illicit substances’ class (Kelly et al., 2014). The third study found three polysubstance use classes: a ‘cannabis, ecstasy and illicit drugs’ class, a ‘cannabis, amphetamine derivatives and illicit drugs’ class and a ‘sedatives and alcohol’ class. Together, these classes represented 14% of the study sample (Quek et al., 2013). Class proportions of the polysubstance use class ranged between 6.6% (Choi et al., 2020), and 21.8% (Snyder & Rubenstein, 2014).

3.5. Latent classes of clubdrugs

Four studies described in this review did not include alcohol as an indicator, instead focusing on frequency of clubdrug

use only (Armour et al., 2014; Chan et al., 2019; Fernández-Calderón et al., 2018; Hannemann et al., 2017). All four studies identified a ‘conservative’ or ‘no polysubstance use’ class with a low probability for having used any substance apart from marijuana. Three of these studies (Armour et al., 2014; Fernández-Calderón et al., 2018; Hannemann et al., 2017) identified a ‘traditional clubdrugs’ class with a higher probability for the use of amphetamines, marijuana, cocaine, ecstasy and speed, and a ‘wide-range polydrug class’. Two studies (Fernández-Calderón et al., 2018; Hannemann et al., 2017) described a ‘psychedelic class’ with a greater probability for using psychedelic drugs.

3.6. Hookah related classes

Two studies (Evans-Polce et al., 2016; Kabir et al., 2018) used hookah-smoking as an indicator, leading to a class structure that is very different from the other 18 studies, including classes like ‘hookah-experimenter’ or ‘non-hookah-tobacco-users’.

3.7. Predictors and covariates of latent classes

All studies but three (Chiauzzi et al., 2013; Choi et al., 2018, 2020) reported odd’s ratios of predictors regressed onto classes, comparing substance use classes to the ‘low-level engagers’ class. Most studies measured effect sizes for predictors of latent class membership via multinomial logistic regression analysis.

3.7.1. Gender

All studies but four (Cadigan et al., 2019; Choi et al., 2020; Fernández-Calderón et al., 2018; Tomczyk et al., 2016) found that gender was associated with class membership: most studies found that men had higher odds of belonging to a ‘heavy use/polysubstance use’ class.

3.7.2. Age

Fifteen studies included age as a covariate, but results were inconsistent. Eight studies found a positive association between age and a higher probability for membership of a ‘heavy use/polysubstance use’ class (Cadigan et al., 2019 (sample 1); Chan et al., 2019; Chiauzzi et al., 2013; Haas et al., 2015; Kabir et al., 2018; Quek et al., 2013; Sañudo et al., 2015; Snyder & Merritt, 2015 (male sample)). Both Cadigan et al. (2019) and Snyder and Merritt (2015) found this positive association in only one study sample. Seven other studies included age as a covariate but did not find a significant association between age and class membership (Choi et al., 2020; R. J. Evans-Polce et al., 2018; Haas et al., 2015; Hannemann et al., 2017; Kelly et al., 2014; Snyder & Rubenstein, 2014 (male sample); Tomczyk et al., 2016). In the female sample, Snyder and Rubenstein (2014) found a positive association between an older age and a lower probability for substance use.

3.7.3. Race/ethnicity

Seven studies investigated race/ethnicity and six of them (Chiauzzi et al., 2013; Fernández-Calderón et al., 2018; Haas et al., 2015; Lanza et al., 2014; Snyder & Merritt, 2015; Snyder & Rubenstein, 2014) found a significant relation between race/ethnicity and class membership. Being white was associated with a higher probability for membership of a 'heavy use/polysubstance use' class. Being African American or Hispanic was associated with a lower probability for alcohol or drug use. These findings were consistent across all six studies.

3.7.4. Socioeconomic status

One study investigated effects of socioeconomic status, evaluated as a result of education and wealth, and found no significant relation with class membership (Sañudo et al., 2015). Eight studies investigated educational attainment or high school completion as a proxy of socioeconomic status and of those, five found that a lower education was related to classes with a higher probability for substance use (Chan et al., 2020; Kelly et al., 2014; Quek et al., 2013; Snyder & Merritt, 2015; Snyder & Rubenstein, 2014). One study found that a lower education was related to a lower probability of substance use (Fernández-Calderón et al., 2018). Two studies found that a higher parental educational status was associated with a higher probability for alcohol or drug use, (Choi et al., 2020; Lanza et al., 2014). Four studies investigated the effects of income on class membership and three of these found that a higher income is related to classes with a higher probability for substance use (Chan et al., 2020; Fernández-Calderón et al., 2018; Quek et al., 2013). Kelly et al. (2014) found a higher income to be predictive of membership of a marijuana, ecstasy and licit drug use. Chan et al. (2020) reported that younger people were more likely to engage in polysubstance use, if they had both a higher income and lower levels of education.

3.7.5. Mental health

Depressive symptoms were investigated in seven studies and were found to predict membership to polysubstance and heavy-use classes in six studies (Chan et al., 2019, 2020; Kelly et al., 2014; Quek et al., 2013; Snyder & Merritt, 2015; Snyder & Rubenstein, 2014). One study did not find this association, but did find a relation between job stress and heavy/polysubstance use (Tomczyk et al., 2016). In one study, self-reported mental disorder was found to predict membership of a 'wide ranging polydrug' class, but only in males (Armour et al., 2014).

3.7.6. Substance use related variables

Six studies investigated substance use related variables as predictors, and found them to predict membership of a heavy use class. Frequency of past 30-day use of drugs, lifetime simultaneous use of two or more substances, current or past alcohol problems, risk perception of driving after marijuana use, alcohol expectancies, past year Non-Medical

Use of Prescription Opioids (NPS) and age of initiation were found to be indicative of membership of heavy/poly-substance use class (Armour et al., 2014; Arterberry et al., 2017; Chiauzzi et al., 2013; R. J. Evans-Polce et al., 2018; Fernández-Calderón et al., 2018; Hannemann et al., 2017). Perceived harmfulness of illegal drugs and nonmedical use of prescription medication (NMUPM) was not found to be indicative of membership of any class (Chiauzzi et al., 2013). Chan et al. (2019) found cannabis use to be predictive of membership of the occasional and regular amphetamines use classes.

3.7.7. Peer substance use

Peer substance use behavior and social norms awareness were investigated in six studies (Chan et al., 2019; Chiauzzi et al., 2013; R. Evans-Polce et al., 2016; Haas et al., 2015; Kabir et al., 2018; Quek et al., 2013). All found a form of influence of peer behavior on membership of a heavy use class. Chiauzzi et al. (2013) found that students who perceived high levels of drinking and drug use as the norm among their peers were more likely to belong to classes that exhibited high levels of alcohol and drug use. Kabir et al. (2018) found that having a friend who smoked increased the risk of membership of a heavy use class. Two studies found that participating in an honor society (Greek affiliation) was associated with being in a heavy drinking and marijuana use class (Evans-Polce et al., 2016; Haas et al., 2015). Quek et al. (2013) found that peer substance use (alcohol tobacco, marijuana) was associated with membership of a heavy use class. Lastly, Chan et al. (2019) found that peer tobacco use was predictive of membership of the occasional and regular amphetamines use classes, but peer alcohol use was not.

3.7.8. Other

Other investigated predictors associated with membership of a heavy/polysubstance use class included: dating violence victimization and perpetration (Choi et al., 2020), anti-social behavior (Chan et al., 2019), childhood neglect or abuse (Armour et al., 2014; Snyder & Merritt, 2015; Snyder & Rubenstein, 2014), general health (Chan et al., 2020) and parental drinking (Snyder & Merritt, 2015; Snyder & Rubenstein, 2014).

4. Discussion

4.1. Latent classes

Of the 20 studies, 14 identified classes with a similar class structure: 'low-level engagers', 'light alcohol and tobacco use', 'heavy alcohol and tobacco use class' and 'heavy use/polysubstance use'. These findings are consistent with findings from Tomczyk, Insensee, and Hanewinkel's (2016) review among adolescents, but findings regarding class sizes differ. In their review, Tomczyk et al. (2016) found the 'low-level engagers' to be the largest class in most studies. In this review, the 'low-level engagers' class was often the second-largest class;

the combined light and heavy alcohol and tobacco classes were the largest in most studies. The reason for this difference is most likely that adolescents are younger and less likely to have been in contact with alcohol.

The studies described in this review all report a *'heavy use/polysubstance use class'*, reflecting a high probability for the use of all investigated substances. However, in most studies this is the only class reflecting the use of any substances beside alcohol and marijuana. Any young adult who used drugs other than alcohol and marijuana in the past year would be a member, regardless of their risk of developing substance use disorders. One *'polysubstance use class'* to encompass all substance use patterns beside alcohol and marijuana is insufficient in terms of prevention, because it does not distinguish between young adults who are at increased risk for developing harmful substance use and those who are not.

Four studies in this review identified classes based on the use of specific types of drugs, e.g., a *'traditional clubdrugs'* class, a *'cannabis, ecstasy and illicit drugs'* class, a *'sedatives and alcohol'* class, a *'wide-range polydrug'* class or a *'psychedelic'* class (Armour et al., 2014; Fernández-Calderón et al., 2018; Hannemann et al., 2017; Quek et al., 2013). Since the risk of developing substance use disorders varies with type of drug and social setting in which the drugs are used (EMCDDA, 2019; Hartogsohn, 2017; Zinnberg, 1986), these classes could be used for the development of selective prevention efforts. For example, the *'wide range polydrug'* profile seems to be at a higher risk of sustaining health issues, because membership of this class is associated with mental health and alcohol problems (Armour et al., 2014; Fernández-Calderón et al., 2018; Hannemann et al., 2017). The *'traditional clubdrugs'* class and the *'psychedelic class'* would also benefit from targeted approaches in terms of selective prevention. First, because the risks involved in using traditional clubdrugs such as ecstasy (e.g., hyperthermia) can be very different from the risks involved in using psychedelics (e.g., psychosis). Second because the settings in which young people using these drugs are found to vary from clubs (clubdrugs) to at home or in nature (hallucinogens). And third, because motives for using a particular substance vary between substances (Meikle et al., 2020; Simons et al., 2000; White et al., 2016; Zimmerman et al., 2019).

Overall, the studies that used a single alcohol related indicator, or no alcohol indicator at all, provided the most diverse insight into drug use patterns. All these studies used *'type of drug'* and *'frequency or pattern of use'* as indicators to model classes. But there are other characteristics that also impact the risk for substance use disorders, like the social setting in which the drugs are used and personal characteristics like socioeconomic status (EMCDDA, 2019; Hartogsohn, 2017; Zinnberg, 1986). Including these indicators could increase insight in characteristics of young adults who are at a higher risk of developing or maintaining different polysubstance use patterns, which in turn could lead to more targeted and effective interventions.

4.2. Predictors

The sociodemographic factors age, gender and race/ethnicity were tested in most studies. Men had higher odds of belonging to a *'heavy use/polysubstance use'* class. Results for age as a covariate were inconsistent, with only some studies finding that a older age was related to classes with a higher level of substance use. However, Tomczyk and colleagues (2016), found gender to deliver mixed results and an older age to be associated with higher odds of belonging to a *'polysubstance use'* class. These incongruous results are most likely the consequence of age differences between the samples. Tomczyk and colleagues included adolescent samples (10-19 years), while this current review included young adult samples (18-25 years). As stated in the introduction, the general starting age for most substances lies between 18 and 25. Also, the use of club drugs is often associated with reaching the legal age for entering clubs and dance venues. So results for a group aged 10-19 can be expected to widely diverge between the 10-year-olds and the 18-year-olds, whereas the results for a group aged 18-25 can be expected to fluctuate less.

Regarding social economic status, both highly educated young people (i.e. college students) and young people with low educational attainment seem to run a heightened risk. Having a higher income also seems associated with a higher probability for alcohol or drug use. The relationship between income and education and its influence on substance use is discussed in two of the included studies (Chan et al., 2020; Quek et al., 2013), both of which suggest that young people with low educational attainment who join the workforce at an earlier age have more disposable income and are therefore more at risk of developing a substance use problem.

Low educational attainment, a history of depressive symptoms or mental illness, and having a history of childhood neglect or abuse were all found to be associated with a higher probability for alcohol or drug use in studies with low or moderate risk of bias. These characteristics may be used to identify vulnerable groups who are at a higher risk of developing substance related health issues, as separate risk factors but also in combination (Armour et al., 2014; Brewin et al., 2000; Font & Maguire-Jack, 2020; Min et al., 2007; Snyder & Merritt, 2015; Snyder & Rubenstein, 2014). Targeting multiple risk factors for alcohol or drug use within one prevention approach may strengthen the impact (Botvin, 2000; Hawkins et al., 1992; Prochaska et al., 2008). Being a member of an honor society was also associated with a higher probability for alcohol or drug use, as was having friends who use substances, having a higher income and having parents with higher education status. These characteristics were also found in studies with a moderate or low risk of bias. As a set, these characteristics have been described in previous studies (Benson et al., 2015; R. Evans-Polce et al., 2016; Lewis & Mobley, 2010; Sher et al., 2011) and point toward a group of students who are at a higher risk of heavy episodic drinking and use of other substances. Certain preventive interventions that target college students are available but focus mostly on the misuse

of alcohol and do not target the use of other substances such as cannabis and ecstasy (National Institute on Alcohol Abuse and Alcoholism, Ryan et al., Ryan et al., 2019). Developers and providers of college interventions should consider expanding current interventions to include the problematic use of other substances in addition to alcohol. They could make it a priority to target the specific groups of students that are known to run a heightened risk for harmful substance use. For example, a skills training for first year members of honor societies to teach them to resist social pressure from fellow members and a personalized normative feedback intervention on campus to provide corrective information about actual levels of peer substance consumption and to counter the tendency for overestimation of peer substance intake. Targeting multiple risk factors for alcohol or drug use within one prevention approach may strengthen the impact (Botvin, 2000; Hawkins et al., 1992; Prochaska et al., 2008).

The results of this review encourage the development and implementation of interventions that target multiple risk factors for substance use within subgroups of young people in certain settings. When targeting a subgroup, it is important to keep in mind that although the collective characteristic increases the risk within the subgroup, on an individual level there will be other characteristics and variables increasing or decreasing that risk. These individual differences within a subgroup should always be observed when developing or implementing an intervention.

4.3. Limitations

Three considerable limitations complicate the comparison of studies in this review. First, the studies investigated dissimilar samples. Samples varied in country of origin, mean age, size and background (students vs general population). Although alcohol is the most used substance in each of the countries (Peacock et al., 2018), there are differences between the countries, such as average amount of alcohol consumed per capita and legality of substances such as marijuana. Differences between samples could affect latent class solutions and prevalence scores. In addition, three studies used samples from Wave III of Add Health and possibly overlap in participants (Lanza et al., 2014; Snyder & Merritt, 2015; Snyder & Rubenstein, 2014). However, close examination of these studies showed that different indicator variables were used in each study, identifying different classes. Therefore it was decided to include the three studies separately.

Second, ten out of 20 studies included multiple alcohol-related indicators, using both alcohol use and binge drinking as an indicator. Alcohol-related indicators might be dependent of one another, which could possibly violate an assumption of LCA (Nylund et al., 2007). In theory, the LCA could statistically weigh toward identifying multiple alcohol-related classes, resulting in multiple alcohol use classes instead of multiple drug use classes. This might make it less likely to distinguish different classes for substance

use other than alcohol, even though such classes could exist. Within LCA, within-class covariance structure can be freed to allow within-class item covariance, but none of the included studies explicitly mentions this, nor a check on issues of collinearity of variables. Also, having a covariance equal to zero does not guarantee that two (or more) variables are independent. It is important to keep in mind that some of the studies included in this review might have found other classes if they adjusted for including multiple alcohol-related indicators. These limitations need to be addressed in future endeavors to identify latent groups of substance use.

Third, substance use class indicators were operationalized in different ways, ranging from past-30-days use of alcohol, marijuana and tobacco to lifetime use of all substances. Some studies used only frequency of use as indicator, others included measures for problematic use of substances as an indicator. Even though all class indicators in the review were substance use related, these differences in frequency and substance might influence the class solution and complicate comparison of the studies.

Other limitations are: 1) the possibility of having overlooked some relevant publications, despite the extensive search of published empirical studies that met the inclusion criteria and 2) the fact that 15 out of the 20 studies had moderate or high risk of bias, mostly as a result of samples not being representative of the average in the target population. However, predictors of class membership that were found in studies with a high risk of bias, were in all cases supported by similar findings in studies with a moderate or low risk of bias.

5. Conclusion

The current review aimed to identify groups of young adults in the general population who are at increased risk for developing harmful substance use or substance use disorders. Awareness of such high-risk groups can contribute to more targeted and effective interventions that take into account which young adults are at a higher risk of developing or maintaining heavy/polysubstance use patterns. The investigated predictors of class membership provide insight into social settings and characteristics that predict heavy use or polysubstance use. A low level of educational, a history of depressive symptoms or mental illness, and a history of childhood neglect or abuse were all consistently across studies associated with a higher probability for heavy alcohol or polydrug use, as were Greek affiliation and peer substance use. These characteristics can be utilized separately or in combination to develop interventions and implementation strategies targeting groups that are at a higher risk of heavy episodic drinking and use of other substance, always staying mindful of the individual differences within the subgroup. This review has added to the literature in this field, but more studies among young adults (18-25 years) are needed that focus on identifying subgroups at a higher risk of substance misuse and substance use disorders.

Author's contribution

MJ, LL and AB set the scope and designed the review. MJ and AB searched the databases and were responsible for screening and data extraction. MJ led on data analysis, and wrote the first draft of the review, AB, LL, SO and MK contributed to the review's structure, and revised the review for important intellectual content. All authors approved the final version of the review.

Declaration of interest

The authors declare that they have no conflict of interest.

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