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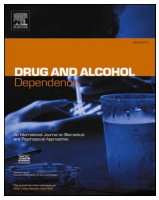

Heterogeneity of definitions and measurements of binge drinking in research on adolescents and young adults

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ABSTRACT

Introduction: Binge drinking is a widespread health compromising behaviour among adolescents and young adults and is one of the leading causes of mortality and injuries among this population. The definitions and measurement methods of binge drinking are heterogeneous but constitute a crucial component in the literature on associated factors related to binge drinking. This study focused on how binge drinking is defined and measured in the literature exploring its associated risk factors among adolescents and young adults.
Methods: The databases PubMed, Embase, PsycINFO and Social Care were searched for articles published between 1 January 2006 and 30 April 2020 using 3 concepts: binge drinking; risk or protective factors; and adolescents/young adults with respective key words. Data were extracted on the main characteristics of studies and the parameters of binge drinking measurements.
Results: 173 studies were included, mostly cross-sectional (61 %) and longitudinal (38 %). Only 23 % of the studies explicitly referred to a standardised definition of binge drinking even though 76 % of the studies used a consensual threshold of 5 drinks or more for men. A lower threshold for women was applied in 26 % of the studies. Recall periods ranged between 2 weeks and 1 year in 85 % of the studies and only 16 % presented binge drinking in terms of frequency and/or quantity of drinks.
Conclusion: Our results highlight the heterogeneity in the definitions and measurements of binge drinking, raising concerns for meaningful comparisons between studies focused on factors associated with the behaviour. The scientific community needs to be aware of these variations and address the gap of poor stratification and inconsistencies in binge drinking reporting.

1. Introduction

Binge drinking has become a widespread health compromising behaviour among adolescents and young adults around the world (Degenhardt et al., 2016; Patrick et al., 2013). Studies have shown that the behaviour reaches its peak in young adulthood, with a dramatic increase being seen during the teenage years and early adulthood (Hingson et al., 2013; Miller et al., 2007). It is one of the leading causes of mortality and injuries among this population (Gore et al., 2011; Patton et al., 2009); can lead to major health problems, primarily related to alcohol dependence later in life (Bonomo et al., 2004; Kuntsche, 2004); and cause long-lasting cognitive psycho-social and cognitive function difficulties (Alcohol Related Disease Consortium* et al., 2018; Carbia et al., 2018; Huurre et al., 2010; Viner and Taylor, 2007).

The definitions and measurement methods of binge drinking, also reported as 'risky single occasion drinking' or 'heavy episodic alcohol use', are heterogeneous, making direct comparison among findings challenging. Nevertheless, the various definitions and measurement methods constitute a crucial component in the literature related to binge drinking. Essential parameters of binge drinking definitions, such as the amount of alcohol consumed, the time during which the behaviour takes place and how fast the person metabolises alcohol, form the subject of debate. A number of standardised definitions of binge drinking are to be found around the world. The National Institute on Alcohol Abuse and

Abbreviations: MeSH, Medical Subject Headings; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RCTs, Randomised controlled trials.

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Alcoholism (NIAAA) in the United States of America (USA) defines a binge drinking episode as the consumption of 5 or more drinks for men and 4 or more drinks for women (Wechsler, 1994), within a 2-hour period. The use of a time qualifier (2-hour period) was included in the NIAAA 2004 definition but its use is controversial (Corbin et al., 2014). Other broadly used definitions include that of the World Health Organization (WHO) and the Substance Abuse and Mental Health Services (SAMHSA). See Table 1 for details regarding the standard definitions of binge drinking used in studies examined in our research. The majority of definitions use a single cut-off (5 standard drinks) despite the fact that there is no clear evidence to support it (Jackson, 2008). Indeed, (Pearson et al., 2016) have argued that any single cut-off on alcohol consumption may lead to a loss of nuance in understanding binge drinking-related events. As such, the use of a "standard drink" in any definition raises questions when the alcohol content of a standard drink varies from one continent or country to another (Kalinowski and Humphreys, 2016). Furthermore, (Patrick, 2016) and (Courtney and Polich, 2009) recently stressed that the existing binge drinking definitions characterize single binge episodes but do not capture consumption patterns. In addition, as pointed out by (Presley and Pimentel, 2006), there are other negative consequences directly related to the increase of frequency of excessive drinking episodes. Simply putting all people who drink a certain number of drinks over a particular threshold defined as constituting the binge drinking threshold, without specifying how much over the particular threshold and how often the person engages in this behaviour results in the nuance of alcohol consumption patterns being lost, and policies being put in place, that may not reflect the various needs of people at different places along this spectrum of alcohol use (Patrick, 2016; Read et al., 2008).

Data on alcohol consumption among adolescents and young adults is mainly based on self-reporting surveys, which can be used with confidence when social desirability bias is minimised and when the underestimation of frequent heavy drinkers is taken into account (Chavez et al., 2011). Self-reporting of alcohol consumption has further been shown to be reliable when measuring substance use among adolescents and young adults on two occasions separated by 7 day intervals (Levy et al., 2004). However recall bias with potential underestimates of alcohol use may appear when recall periods go beyond a couple of days (Ekholm, 2004).

While conducting a systematic review exploring the factors associated with binge drinking in adolescence and young adulthood (Hasselgård-Rowe et al., 2017), we were struck by the extent to which heterogeneous definitions and measures of binge drinking made the analysis of the factors associated with binge drinking in adolescents and young adults challenging, since the definitional and measurement differences meant that associations with risk or protective factors could be skewed, and study results could not be accurately compared.

Mapping the different definitions and measurements of adolescents and young adults' binge drinking was a necessary first step to understanding the factors associated with this type of alcohol use. The aim of

Table 1
Standard definitions of binge drinking used in studies examined in our research.

Name of the source	Definition	Year of definition used	Precise reference	Timeframe included in definition	Quantity	Gender distinction
Substance Abuse and Mental Health Services Administration (SAMHSA) *	Have had five or more alcoholic drinks on the same occasion on at least 1 day in the past 30 days. Occasion was defined as having the drinks at the same time or within a couple of hours of each other.	2008	Substance Abuse and Mental Health Services Administration. (2021). *Key substance use and mental health indicators in the United States: Results from the 2020 National Survey on Drug Use and Health* (HHS Publication No. PEP21-07-01-003, NSDUH Series H-56). Rockville, MD: Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration. See https://www.samhsa.gov/data/	"Same occasion or within a couple of hours"	5 or more drinks	No
Australian National Health and Medical Research Council (NH&MRC) Guidelines	Four standard drinks for females, and more than six standard drinks for males on one occasion	2001	National Health and Medical Research Council, 2001. Australian Alcohol Guidelines: Health Risks and Benefits. NHMRC, Canberra.	"On one occasion"	4 or more drinks for females and 6 or more drinks for males	Yes
The European School Survey Project on Alcohol and Other Drugs (ESPAD)/ Health Behaviour in School-aged Children (HBSC)	Five or more drinks on one occasion during the last 30 days	2015	European School Survey Project on Alcohol and Other Drugs. (2015). See www.espad.org	"On one occasion" but number of hours not specified	5 or more drinks	No
World Health Organization (WHO)	Drinking at least 60 g or more of pure alcohol on at least one occasion in the past 30 days.	2004	World Health Organization (2014). Global status report on alcohol and health. Geneva: WHO Press 2014. See http://www.who.int	"On one occasion"	60 g or more of pure alcohol	No
National Institute on Alcohol Abuse and Alcoholism (NIAAA)	A pattern of drinking alcohol that brings blood alcohol concentration (BAC) levels to 0.08 g per deciliter (g/dL) or above. For the typical adult, this pattern corresponds to consuming five or more drinks (male), or four or more drinks (female), in about two hours.	2004	National Institute on Alcohol Abuse and Alcoholism. (2004, Winter). NIAAA council approves definition of binge drinking. *NIAAA Newsletter*, 3. See https://pubs.niaaa.nih.gov/publications/Newsletter/winter2004/Newsletter_Number3.pdf.	" In about 2 h "	4 or more drinks for females and 5 or more drinks for males	Yes
Centre for Disease Control (CDC)	Consuming 4 or more drinks on an occasion for a woman or 5 or more drinks on an occasion for a man.	2018	See https://www.cdc.gov/chronicdisease/resources/publications/factsheets/alcohol.htm; https://www.cdc.gov/chronicdisease/resources/publications/factsheets/alcohol.htm	"On one occasion"	4 or more drinks for females and 5 or more drinks for males	Yes

the present study is therefore to describe how binge drinking is defined and measured when exploring its associated risk factors among adolescents and young adults. This includes identifying and examining elements such as recall periods, time qualifiers, gender thresholds, as well as stratification of binge drinking according to intensity (frequency and quantity).

2. Methods

2.1. Protocol and registration

The present study emerged from the preliminary data analysis of the systematic review of the literature addressing factors associated with binge drinking among adolescents and young adults (between the ages of 15 and 24). Although this systematic review was the driving force for this study, it is not related to the rest of the present study other than affecting the selection of studies included. The protocol for the review on which this study is based was published in 2017, and was registered in PROSPERO (ref: CRD42016032496) (Hasselgård-Rowe et al., 2017).

2.2. Information sources and search strategy

The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations (Moher, 2009). The following bibliographic databases were searched for articles published over 10 years, between 1 January 2006 and 31 December 2015: PubMed, Embase, PsycINFO and Social Care. We decided not to go further back in time, given the increase of the phenomenon of binge drinking in many Western societies over the past fifteen years, and the fact that we wanted to explore the most recent developments in this field. The initial literature search was then extended to cover the time period from 1 January 2016–30 April 2020, so as to incorporate even more recent findings from the literature. The primary search question was divided up into 3 concepts: binge drinking (concept 1); risk or protective factors (concept 2); and adolescents and young adults (concept 3). The key words were 'binge drinking' or 'risky single occasion drinking' or 'heavy episodic drinking' for concept 1; 'risk factors', 'lifestyle' ('life style') for concept 2; and 'adolescent', young adult, young people, teen, teenager, juvenile, youth, underage' for Concept 3; The details of the search strategy for this systematic review of the factors associated with binge drinking among adolescents and young adults are found in the Protocol on which this study is based (Hasselgård-Rowe et al., 2017) and the search strategy is also included in Appendix A. In addition, we scanned the reference lists of relevant articles to identify any further interesting sources. Note that the exact same search equations and procedures were used for the second search period (between 1 January 2016 and 30 April 2020). See Table 2 for more detailed information regarding the characteristics of the records examined.

2.3. Eligibility criteria

With regard to the study designs, the systematic review focused on observational studies (cross-sectional, cohort and case-control studies), while randomised controlled trials, case series and case reports were excluded because they were likely to involve selection bias of particular binge drinking populations.

2.4. Study selection

A data extraction form was used to record each study and whether it should be excluded, if it did not meet one of the four inclusion criteria listed as follows:

1. The study outcome focuses on binge-drinking; not on other alcohol use disorders such as alcohol dependence;
2. The study is observational (cross-sectional, cohort and case-control);
3. The study focuses on or analyses and presents specific results for young persons between the ages of 15 and 24;
4. The variables explored constitute risk or protective factors for binge drinking specifically. The timing of the risk factors of relevance to this study means they need to precede or be concurrent with the binge drinking, not post.

Table 2
Main characteristics of the 173 studies included in the systematic review.

Location	North America: 104 (60 %)
	Europe: 42 (24 %)
	Asia: 8 (5 %)
	Oceania: 7 (4 %)
	International: 6 (3 %)
	South America: 4 (2 %)
	Central America and Caribbean: 2 (1 %)
Study design	Cross-sectional: 105 (61 %)
	Longitudinal: 65 (38 %)
	Case control: 3 (2 %)
Study sample	High school students: 60 (35 %)
	Specific populations: 47 (27 %)
	Representative youth population: 37 (21 %)
	University students: 29 (17 %)
Number of participants	More than 10′000: 39 (23 %)
	5001–10′000: 26 (15 %)
	2001–5000: 30 (17 %)
	1001–2000: 18 (10 %)
	501–1000: 29 (17 %)
	Less than 500: 31 (18 %)
Data collection method	Self-administered (paper or online) survey: 145 (84 %)
	Personal interview (face to face or phone): 16 (9 %)
	Mixed methods: 12 (7 %)

The types of studies selected were limited to observational studies and did not include purely qualitative studies. The studies included in our review were limited to studies published in English. The selection of relevant studies followed a three-step process. First, two reviewers (JHR and DMH) independently screened the titles and abstracts of the collected articles, according to the inclusion criteria. Second, the reviewers (JHR and AS) went over the full-texts of the articles to determine inclusion of the full texts. Third, results were compared and when questions arose, the reviewers resolved their disagreements by discussion and consensus (JHR, AS and DMH). Fig. 1 represents the data collection Selection Flowchart, set out in accordance with the PRISMA Flowchart (Page et al., 2021).

2.5. Data collection process

Two investigators (JHR and AS) extracted the following data for each study, in accordance with a data extraction/coding sheet which they developed and pilot-tested on ten randomly chosen articles from the full-texts included in the final analysis: the type of factor explored; the location of the study; the study design; the study population; and the data collection method used to characterise binge drinking. They also collected information regarding the parameters of binge drinking: such as the quantity and gender thresholds; the timeframe during which drinking occurred; the recall period; whether information on the intensity (frequency or quantity) of binge drinking was included; and whether explicit reference was made to a standardised definition of binge drinking. We coded each reference according to whether explicit reference was made to a standardised definition of binge drinking. The coding we used was as follows: 1 = Substance Abuse and Mental Health Services Administration (SAMHSA) definition; 1b = variation of the SAMHSA definition with regard to the recall period, ie so include 2 weeks and 4 months or 1 year; 2 = Australian definition from the Australian: National Health and Medical Research Council (NH&MRC) Guidelines (2001); 3 = European School Survey Project on Alcohol and Other Drugs (ESPAD)/ Health Behaviour in School-aged Children (HBSC); 4 = self-definition; 5 =World Health Organization (WHO)

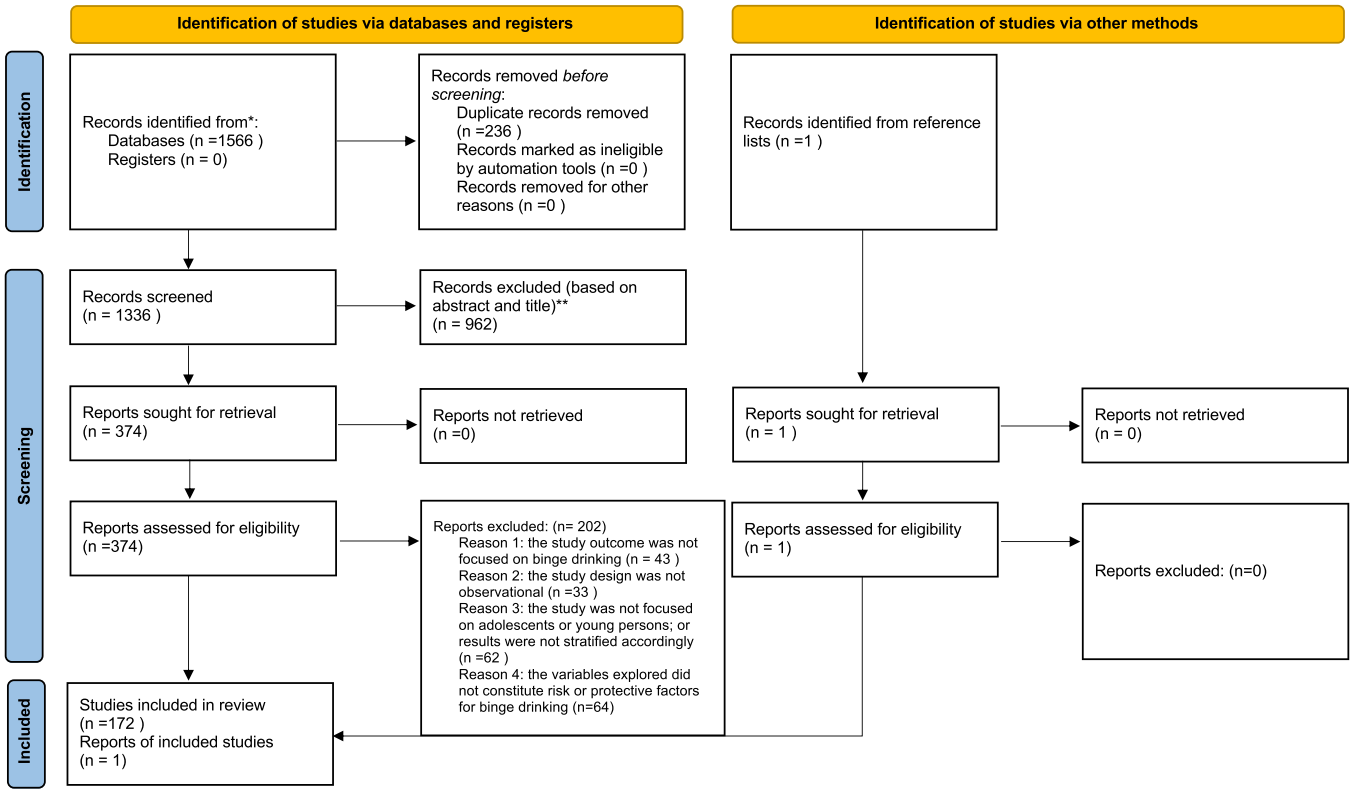

Fig. 1. PRISMA diagram for our systematic review of risk and protective factors for binge drinking among young persons (studies published between 2006 and 2020).

2004; 6 = National Institute on Alcohol Abuse and Alcoholism (NIAAA); 7 = biological measures. 8 = Centre for Disease Control (CDC) definition. See Table 1 for more details on these definitions.

2.6. Quality assessment

We did not conduct a quality assessment because during the course of extracting data for the quality assessment of articles, we found that the binge drinking definitions and measurement tools were so heterogeneous that it limited the possibilities of comparison. This paper therefore presents solely results relating to the definitions and measurement tools used in the studies included in the review.

3. Results

3.1. Study selection

Our search strategy resulted in a total of 1567 references identified through the database search equations. 375 references were retained for full analysis. After reviewing each of these articles, 173 were included in our final, thematic qualitative synthesis. The details pertaining to each of the references included in this review are set out in Appendix B. We present a summary of the main characteristics of the studies in Table 2.

3.2. Study characteristics

Table 2 provides information on the characteristics of the references included in our systematic review covering the location, study design, study sample, number of participants and data collection methods of the studies. For more details see Appendix B.

The vast majority of studies (more than 84 %) came from North America and Europe followed by Asia-Pacific region. Brazil alone represented South America and there were no studies from Africa. The international studies consisted of aggregation of several countries in one study Siliquini et al. (2012))or comparisons between countries in different regions (Peltzer and Pengpid, 2016) for example. We were not able to classify participants by standard age ranges, as the majority of studies were conducted in school settings where the data was collected according to grades, not specific ages. The relationship between school grades and ages varies widely across countries due to distinct educational systems with different subdivisions in schools by ages and/or grades. The category of 'specific populations' was made up of studies that enroled adolescents and young adults belonging to ethnic or gender minorities or being followed or treated for other biological or psychological disorders.

There was no real difference in terms of number of participants in the cross-sectional and longitudinal studies. The few case control studies (n = 3) all had small numbers of participants (less than 100). The vast majority of studies used self-administered (paper or online) surveys, with a minority of studies using personal interviews (9 %) and mixed methods (7 %). This is to be expected, given that for the most part, the data collection was primarily based on widespread surveys.

The majority of studies employed the term 'binge drinking', but a number of studies also used 'heavy episodic drinking' (HED) or 'risky single occasion drinking' (RSOD) to refer to the behaviour of consuming 5 or more drinks on one occasion. As can be seen from Fig. 2, the majority of studies (77 %) did not make explicit reference to a standard definition of binge drinking and three quarters of the studies (76 %) used a threshold of 5 or more drinks for men. For the studies that did not use the 5 or more drinks threshold, for the most part a cut-off of 4 or 6 or more drinks was used. This can be partially explained by the use of the WHO and Australian definitions which respectively consider binge drinking as consuming more than 60 g of alcohol, equivalent to 6 drinks (Dietze and Livingston, 2010). Biological sex thresholds (of 4 or more drinks for women) were only made in about a quarter of the studies (26 %). In most of the studies (78 %), the **timeframe of binge drinking**

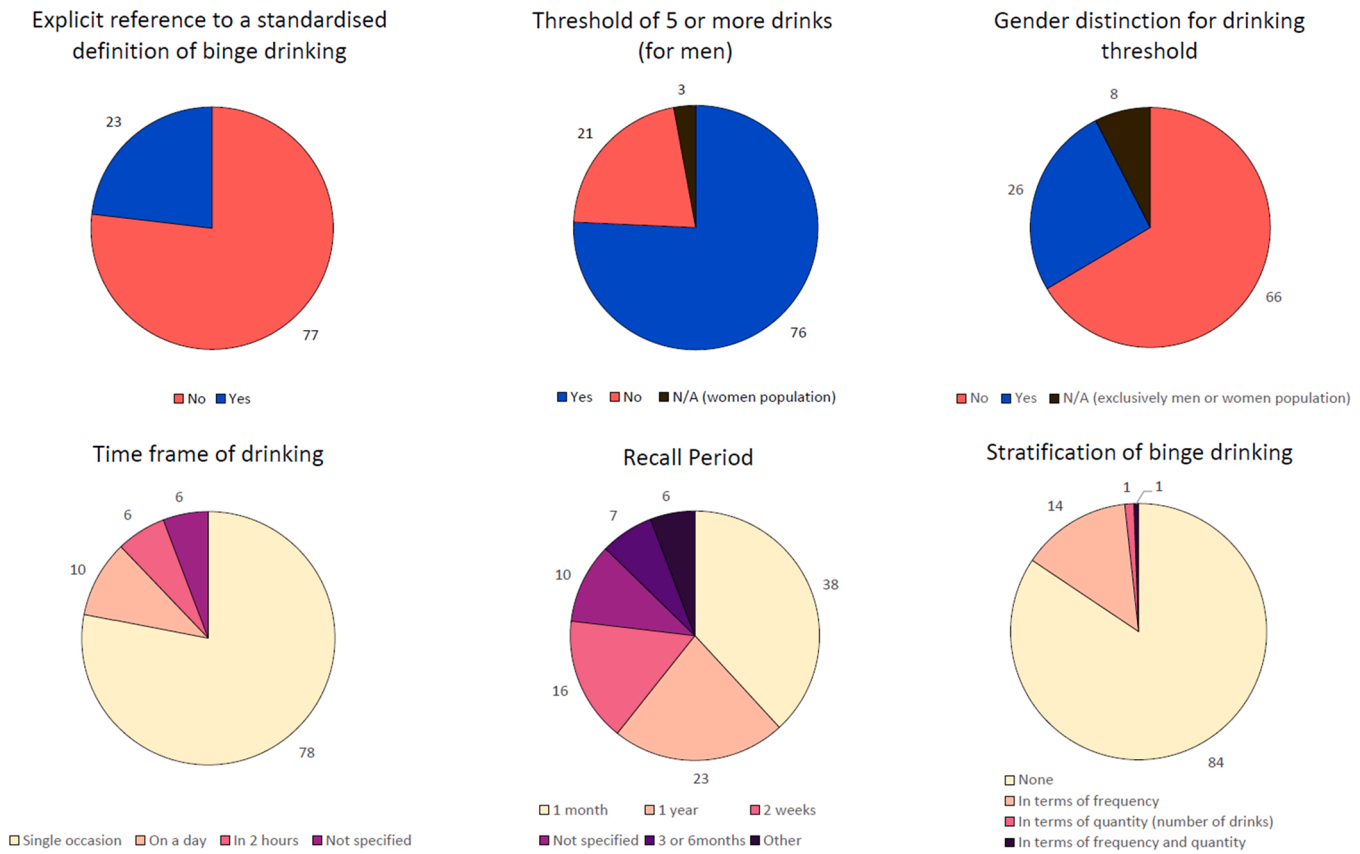

Fig. 2. Characteristics of binge drinking assessment in the 173 references studies included in the systematic review. All numbers are expressed as percentages.

episodes consisted of one occasion, with a variety of synonymous terms such as "in a row", "one setting", "one time" being used across the studies. Ten percent of studies referred to a drinking day, while only 6 % used the NIAAA timeframe of 2 h. The **recall period for binge drinking** was extremely varied, ranging from 1 day to a year and highly dependent on the study design. The cross-sectional studies mostly used a recall period of 2 weeks or one month, while the longitudinal studies most often went back a year. Of note, for ten percent of the studies, we were not able to identify a recall period. Finally, there were very few studies that **stratified binge drinking by frequency (14 %)** and hardly any by **quantity** (1 %) in their results.

4. Discussion

4.1. Summary of main findings

This systematic review presents preliminary findings of the systematic review, revealing how binge drinking is currently defined and measured in observational studies focusing on factors associated with binge drinking among adolescents and young adults. Our results illustrate the heterogeneity in the definitions and measurements of binge drinking. However, the '5 drinks in a single occasion' threshold can be considered the normative cut-off, regardless of explicit reference or not to one of the existing standardised definitions of binge drinking. It is, nonetheless, also limited by the discrepancy of what is considered a standard drink. In the USA, a standard drink is equivalent to 14 g of alcohol whereas in the majority of European, Asian and Oceanic countries around the world, a standard drink contains between 10 and 12 g of alcohol (Kalinowski and Humphreys, 2016). Furthermore, there was great variability exhibited in the use of a lower threshold for women as well as the recall period and hardly any stratification based on frequency and quantity that would pick up the phenomenon of extreme binge drinking (Patrick et al., 2013). Only a quarter of the studies used a lower threshold of 4 or more drinks for biological females. Doing so may increase the identification of women considered to be drinking at harmful levels regardless of change in drinking behaviour and can therefore lead to misguided and/or inaccurate conclusions (Chavez et al., 2011). The recall period was the most heterogenous indicator, with most of the variation being related to the study design.

4.2. Implications

As evidenced above, a number of binge drinking definitions are used in the literature assessing the factors associated with this behaviour among adolescents and young adults. Therefore, it is not easy to capture the influence of individual factors on binge drinking behaviour. Our results point out study population and methodological pitfalls to be aware of when further exploring associated factors for binge drinking among adolescents and young adults.

In terms of study populations, we highlight that the predominance of studies in North America (60 %) could shift conclusions of the studies if applied to other countries and hence also limit the generalisability of the results to other countries around the world. Along these lines, the fact that the European and Australian studies (with different quantities of alcohol per standard drinks than the studies conducted in America) do not propose different binge drinking definitions from the one mostly used in the United States of America may have consequences on the interpretation of results, and significantly, on when someone is considered to have reached the point of their behaviour constituting binge drinking. Moreover, the studies included in our analysis had high numbers of participants and were mostly conducted in school settings (78 %), meaning that they were for the most part categorized and analysed based on grades rather than ages, which may differ across countries. Analysing binge drinking behaviour in early to middle and

late adolescence ought perhaps to be considered in terms of school environments rather than age.

Our review confirms that the term binge drinking may capture a wide variety of drinking patterns ranging, for example, from a young female drinking 4 or more drinks on one occasion to a young man drinking 7 or 8 or even 10 drinks several times per week. We suggest conducting distinct analyses according to study design (cross-sectional and longitudinal) because there is a risk of underestimating binge drinking behaviour in longitudinal studies (which generally have longer recall periods) compared to cross-sectional studies (with shorter recall periods) (Ekholm, 2004; Levy et al., 2004). Most of the studies dichotomized drinking behaviour into two groups (binge versus not binge drinking), despite oftentimes making a distinction with regard to frequency of binge drinking in their methodologies, but then not developing it further in the study results. As such, there was hardly any refinement of binge drinking in terms of frequency and quantity. This may make sense from a public health perspective when roughly classifying large population drinking habits, but may prove limited when applied to clinical settings. In addition, current binge drinking definitions and measurements do not take into consideration developmental aspects of adolescence, with its physical and metabolic variations and changes over time (Donovan, 2009; Spear and Varlinskaya, 2011). In order to further explore clinically relevant factors associated with binge drinking, the study selection should be narrowed to studies that use short recall periods and measure frequency and quantity.

5. Limitations

Our study presents certain limitations. First, this review examines binge drinking definitions and measurements within a sub-group of studies focusing on associated factors only. It does not cover the entire literature focusing on binge drinking among adolescents and young adults and therefore cannot be applied to the entire field. Second, using the protocol as the basis for our study also meant that we included 'general populational studies' not conducted in clinical settings, resulting in a possible bias: our results may not be considered applicable in such contexts. Moreover, while observational studies focusing on specific populations were not to be excluded from the initial inclusion criteria, upon closer examination, the results arising from these studies of specific populations were limited in terms of their applicability to wider populations." Finally, we did not fulfil the fundamental objective of the systematic review: to evaluate the factors associated with binge drinking. Nonetheless, because we identified early on that the way the outcome (binge drinking) is measured was not homogenous and that this limited our possibility to synthesise this literature in a meaningful way, our study constitutes an essential preliminary step to being able to conduct a proper evaluation of selected studies based on population and measurement criteria.

6. Conclusion

In this study focusing on factors related to binge drinking, our results highlight the heterogeneity in the definitions and measurements of binge drinking, raising concerns for adequate comparisons between behaviours considered as binge drinking in various studies. Our findings confirm poor emphasis on stratification of binge drinking with regard to frequency and quantity, as well as gender distinctions and recall periods. In order to better understand the factors associated with binge drinking, and capture its various nuances, future studies on the subject need to provide greater precision and consistency in how they measure the behaviour. The current definitions, that for the most part only use a specific threshold based on a certain quantity of alcohol over time and exclude physiological aspects such as a person's weight and height and how quickly or slowly he or she metabolises alcohol". may lead to differences of binge drinking interpretations around the world. Depending on the definitions of binge drinking and methods of measurement employed, studies may lead to under or overestimations of binge drinking, be misleading with regard to its associated factors, and also influence measures of effectiveness of interventions. This in turn can have negative consequences in terms of prevention policies as measures put in place may not be in response to precise needs. Therefore, comparing factors relating to binge drinking should be undertaken with caution. The scientific community needs to be aware of these variations and address the gap of poor stratification and inconsistencies in binge drinking reporting.

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Competing interests

The authors declare that they have no competing interests.

CRediT authorship contribution statement

Jennifer Hasselgard-Rowe: Conceptualization, Methodology, Software, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualisation, Project administration, Funding acquisition. **Arun Senchyna:** Formal analysis, Investigation, Data curation, Writing – review & editing, Visualisation. **Dagmar M. Haller:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing – review & editing, Supervision, Funding acquisition. **Barbara Broers:** Conceptualization, Writing – review & editing, Funding acquisition.

Authors' contributions

JHR, DH and BB conceptualised the study. JHR and DH developed the study design and protocol. JHR and DH screened all of the retrieved articles, including assessing the 375 full-texts for eligibility. JHR and AS then analysed and conducted the coding of the 173 full-text references included in this work. The details for each reference are included in **Appendix B "Excel file of analysis of full-texts included in our study"**. JHR wrote the first draft of this manuscript. All authors read, revised and approved the final manuscript.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.drugalcdep.2022.109650.

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