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ABSTRACT

Purpose: To identify factors associated with drinking patterns during pregnancy.

Design: A rapid evidence assessment was undertaken, scanning multiple databases for studies examining factors associated with alcohol consumption in pregnancy. Studies were included if they stratified data according to quantity of alcohol consumed and identified relevant associated factors. Drinking patterns were classified as light/moderate and heavy/binge.

Findings: Fifteen studies were included (N=7 light/moderate; N=15 heavy/binge drinking).

Factors associated with alcohol consumption during pregnancy included: smoking, age, SES, marital status, pre-pregnancy substance use and parity. While few studies reported an association between heavy/binge drinking and maternal mental health, none of the studies included explored the association between mental health and light/moderate drinking. **Research limitations/implications:** Relatively few studies have looked at the association between psychological characteristics of women and their drinking patterns. There is a lack of articles examining light/moderate drinking in pregnancy compared to heavy/binge drinking. Moreover, there is marked variation in how alcohol use is measured. Further studies are needed to increase understanding of the association between psychological factors and patterns of drinking during pregnancy, and how health professionals might support women in this context.

Originality/value: We expand on previous work by examining two different patterns of alcohol consumption in pregnancy, rather than alcohol use simply as an isolated concept. The two groups were found to differ in a number of demographic and social factors. This information could be used to aid healthcare professionals in targeting specific interventions to those women most at risk.

Key words: Drinking patterns, pregnancy, risk factors, and rapid evidence assessment

INTRODUCTION

Alcohol is one of the most commonly used teratogens in the world (Ornoy, 2010) and its consumption during pregnancy increases the risk of a wide range of adverse fetal outcomes, including low birth weight, intra-uterine growth retardation, spontaneous abortion and pre-term birth (Patra et al., 2011). It is also associated with a multitude of long-term physical, behavioural and neuropsychological deficits to the offspring, which come under the general classification of Fetal Alcohol Spectrum Disorder (FASD) (Williams, 2015). The prevalence of alcohol consumption in pregnancy varies throughout the literature (ranging from 20% to 80%) (O'Keeffe et al., 2015) and across countries (Popova et al., 2017). High rates of drinking during pregnancy have been reported in European countries; the UK and Ireland, for example, have some of the highest prevalence (41.3% and 60.4%, respectively), while Sweden has one of the lowest (9.4%) (Popova et al., 2017). Whilst there is some evidence suggesting that alcohol consumption during pregnancy has decreased over the last two decades in the general population (a decreased prevalence between 20% and 50%) (Cameron et al., 2013; Grant et al., 2009; Ihlen et al., 1993) the rate of high risk drinking patterns (e.g., binge drinking) during pregnancy has remained stable (Cameron et al., 2013).

There is no safe level of alcohol consumption during pregnancy (Henderson et al., 2007; Patra et al., 2011). Policy recommendations about alcohol use in pregnancy varies across countries. Complete alcohol abstinence is recommended in many Western countries such as USA, Canada and France. UK clinical guidelines currently advise against consumption of any alcohol when pregnant and/or trying to conceive, stating that whilst risk of harm to the fetus is low when only small amounts are consumed, the safest course of action is to abstain completely (Department of Health, 2016). Nevertheless, much is debatable about the clinical guidelines as the evidence base to recommend complete abstinence is insufficient. Meta-analyses of the effects of low-to-moderate levels of prenatal alcohol consumption on pregnancy and longer-term

offspring outcomes show limited evidence for a causal impact of low alcohol in pregnancy (i.e., up to 32 g/week - or 4 UK units), compared with abstaining (Mamluk et al., 2017). This inconclusive evidence has been influenced by the paucity and poor-quality design of studies in this area (Mamluk et al., 2017). The authors concluded that *“Formulating guidance on the basis of the current evidence is challenging. However, describing the paucity of current research and explaining that ‘absence of evidence is not evidence of absence’, appears warranted”* (Mamluk et al., 2017). Recent studies advocate the need for health professionals to be trained to communicate information about abstinence in a balanced and rational format (Dumas et al., 2018; O’Leary & Bower, 2012).

The impact that alcohol is likely to have on the pregnancy and infant has been shown to depend on the pattern of consumption, i.e. quantity, frequency and timing of exposure (May & Gossage, 2011). While there is no “safe trimester” in which to drink, longitudinal studies show that after an initial decline in drinking rates during the first trimester, there is a steady increase towards the end of pregnancy (Ethen et al., 2009). The identification of hazardous drinking during pregnancy has proved to be challenging. Women tend to under-report drinking during pregnancy, *largely influenced by the avoidance of shame and stigmatization*. There is a need to develop assessments that identify correctly the women who are at risk.

Health behaviours during pregnancy have been shown to be influenced by the women’s psychological and social environment (Crozier et al., 2009; Ingall & Cropley, 2010; Wen et al., 2010;). Worldwide, about 10% of pregnant women experience a mental health disorder, primarily depression or anxiety (WHO, 2014). Depression is the most common cause of morbidity during pregnancy (Bennett et al., 2004; Michaud et al., 2001) and women from socially and economically disadvantaged backgrounds are at high risk of developing prenatal depression (Fisher et al., 2012). The literature on the association between drinking and mental health problems is large (e.g., Crum et al., 2013; Fergusson et al., 2009; Lopis et al., 2006) . Less is known however, about women’s mental health and drinking patterns in pregnancy.

Planning evidence-based health-promoting programmes requires understanding of the factors associated with high risk drinking patterns during pregnancy. Improved knowledge about risk factors for different patterns of drinking in pregnancy could inform and support health care professionals to deliver individualised recommendations to pregnant women about the harms caused by drinking. **There is also a need for the identification of individual and contextual factors that could serve as barriers or facilitators to successful interventions designed to support women who are at great risk for having an offspring with FASD.**

The purpose of this review was to conduct a rapid assessment of existing evidence on factors associated with alcohol consumption in pregnancy. The current study aims to expand upon a previous review of the predictive factors conducted by Skagerstrom et al. (2011). Specifically, while the previous review only explored studies that collected data in the antenatal period, the current review has no restriction on the time point of data collection. It has been argued that retrospective reporting might give a more reliable indication of drinking habits, as the confounders of social desirability bias and stigma are less likely to influence responses (Hannigan et al., 2010). Furthermore, the current review aimed to overcome the limitation of Skagerstrom et al. (2011) who neglected to consider factors associated with different drinking patterns, e.g., light/moderate drinking vs. heavy/binge drinking. This is an important distinction to make when assessing characteristics of women who drink in pregnancy, given the disparity in outcomes between these groups (Walker et al., 2011).

METHODS

Criteria and search strategy

A rapid evidence assessment (REA) was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Moher, 2009). **Briefly, a REA is a knowledge synthesis method that uses components of the systematic review process in a simplified and**

timely manner (Abrami et al., 2010; Tricco et al., 2015). In the context of this review it means restrict number of databases searched, exclusion of grey literature and limit the scope of the evidence synthesis by, for example, not considering the methodological quality of the studies.

Studies were considered eligible if they met the following criteria: i) quantitative data were collected concerning specific patterns of alcohol consumption (i.e. low intake, moderate, heavy or binge drinking); ii) any factor associated with drinking including sociodemographic, contextual and psychological characteristics was assessed; iii) samples were drawn from the general population and not focused on specific subpopulations (e.g. prisoners, those with unwanted pregnancy etc.); and iv) published in English in a peer reviewed journal.

The following electronic databases were searched from inception until the June 2019 for potentially relevant studies: Medline, CINAHL, Cochrane library and PsychInfo. The searches were carried out using key words and MESH terms. Forward and backward searching of references was conducted and reference lists of recent relevant reviews were cross-checked to verify all relevant studies were included in the current REA. MM and MC independently screened all titles and abstracts and potentially eligible full-text manuscripts against eligibility criteria. Discrepancies were discussed and disagreements resolved through consensus.

Data Extraction

A standardised form was used to extract relevant data on study methodology and findings. The following information from each study was extracted: title, authors, publication year, country, study design, participant characteristics (response rate, average age, sample size), alcohol measurement tool, definition of drinking patterns in the study, time of the data collection, i.e., during/after pregnancy, gestational period(s) of data collection.

RESULTS

A flowchart of the article review process is shown in figure 1. A total of 1490 citation records were identified from searching the four relevant databases (see supplement material for main search terms used in the databases). An additional 5 articles were identified from hand-searching. After removal of duplicates, 1475 titles and abstracts were screened for potential relevance and 95 full-text manuscripts were assessed in full for eligibility. Of these, 80 articles were excluded. After application of exclusion criteria, a total of 15 studies remained for our analysis. Drinking patterns during pregnancy were classified into two groups, light/moderate drinking and heavy/binge drinking as defined by individual studies.

- *Description of studies*

The 15 studies included in this review are described in Table 1. All studies were conducted in “Western” countries with four published in Denmark (Iversen et al., 2015; Niclasen, 2014; Kesmodel, 2003; Strandberg-Larsen et al., 2008), two published in each of Australia (Cameron et al. 2013; Tran et al., 2015), US (Ethen et al., 2009; Flynn et al., 2003), and Canada (Gladstone et al., 1997; McDonald et al., 2014), and one published in England (Coathup et al., 2017), Norway (Alvik et al., 2006), France (Dumas et al., 2017), Ireland (Mullally et al., 2011) and Sweden (Göransson et al., 2003).

Sample sizes of the studies ranged from 432 participants to 85,434. Age was not reported in all studies but for those studies in which it was, the mean age range varied from 28.0 to 32.6 years old. All of the studies included were observational. Six were longitudinal studies collecting data prospectively at multiple time points throughout gestation (Alvik et al., 2006; Cameron et al. 2013; Kesmodel et al., 2003; McDonald et al., 2014; Strandberg-Larsen et al., 2008; Tran et al., 2015) and three were longitudinal studies using retrospectively collected data (Coathup et al., 2017; Mullally et al., 2011; Niclasen, 2014). Six were cross-sectional studies (Dumas et al., 2017; Ethen et al., 2009; Flynn et al., 2003; Göransson et al., 2003; Gladstone and Nulman,

1997; Iversen et al., 2015). The gestational period for data collection varied across studies, from alcohol intake in the early stages of pregnancy only (Coathup et al., 2017; Iversen et al., 2015; Mullally et al., 2011) to later stages of pregnancy only (Dumas et al., 2017; Simmat-Durand et al., 2017; Ethen et al., 2009). However, the majority of studies in this review attained data at various stages throughout pregnancy (Alvik et al., 2006; Cameron et al., 2013; Kesmodel et al., 2003; McDonald et al., 2014; Niclasen, 2014; Strandberg-Larsen et al., 2008; Tran et al., 2015).

Insert Table 1 here

Assessment of alcohol patterns

Seven studies reported factors associated with light/moderate drinking (Cameron et al., 2013; Dumas et al., 2017; Flynn et al., 2003; Göransson et al., 2003; Mullally et al., 2011; Tran et al., 2015; McDonald et al., 2014;) and fifteen studies reported factors associated with heavy/binge drinking (Alvik et al., 2006; Cameron et al., 2013; Coathup et al., 2017; Dumas et al., 2017; Ethen et al., 2009; Flynn et al., 2003; Gladstone et al., 1997; Göransson et al., 2003; Iversen et al., 2015; Kesmodel et al., 2003; McDonald et al., 2014; Mullally et al., 2011; Niclasen, 2014; Strandberg-Larsen et al., 2008; Tran et al., 2015). The criteria for light/moderate consumption was relatively consistent varying between 1 to ≤ 2 drinks per occasion. However, the definition of high risk drinking patterns varied across studies. For example, Mullally et al. (2011) defined high risk drinking as consuming >20 units a week, whereas McDonald et al. (2014) classified it as either 2 drinks per occasion per week or ≥ 3 drinks per occasion at any time in pregnancy, and Göransson et al. (2003) as consuming ≥ 2 drinks per month. Binge drinking was defined by the majority of studies as constituting ≥ 5 standard units per occasion (Alvik et al., 2006; Cameron et al., 2013; Iversen et al., 2015; Niclasen, 2014). High risk and binge drinking were combined in this review due to the overlap in the criteria used in some studies.

Factors associated with light/moderate drinking (n=7)

Smoking either before or during pregnancy was reported among those women who drank light/moderate levels of alcohol by four studies (Cameron et al., 2013; Flynn et al., 2003; Mullally et al., 2011; McDonald et al., 2014). Compared to **abstaining women**, light/moderate alcohol consumption was more common in older women rather than younger women (Cameron et al., 2013; Dumas et al., 2017; Flynn et al., 2003; Göransson et al. 2003), among women with higher levels of education (Cameron et al., 2013; Dumas et al., 2017), higher household incomes (Cameron et al., 2013; Dumas et al., 2017) and among those in employment (Mullally et al., 2011). Married women were more likely to consume light/moderate levels of alcohol in pregnancy **than single women in one study** (Tran et al., 2015). Light/moderate drinking was associated with pre-pregnancy drinking levels including previous involvement in binge drinking in two studies (Göransson et al., 2003; McDonald et al., 2014). One study found an association between pre-pregnancy substance use and light/moderate drinking **when compared to abstainers** (Cameron et al., 2013). One study found that **light/moderate drinking was associated** with having had four or more children **when this group was compared to women of lower parity** (Tran et al., 2015). However two other studies found the opposite; **there was a trend for women who reported light/moderate drinking to be nulliparous** (Dumas et al., 2017; Mullally et al., 2011). None of the included studies reported an association between mental health problems and light/moderate drinking. One study found that having experienced fewer adverse life events (i.e., major job changes, problems with police, housing problems, financial problems, health problems, loss (death) of relatives, serious troubles at work, serious disagreement with partners and marital breakdown) was associated with light/moderate drinking in **comparison to total abstinence** (Tran et al., 2015).

Factors associated with heavy/binge drinking (n=15)

The most consistent association reported across the studies was between heavy/binge drinking and smoking. Of the fifteen studies, thirteen reported that those women who smoke before/during pregnancy **were more likely to engage in binge/heavy drinking compared to women who did not smoke** (Alvik et al., 2006; Cameron et al., 2013; Coathup et al., 2017; Dumas et al., 2017; Ethen et al., 2009; Flynn et al., 2003; Gladstone et al., 1997; Iversen et al., 2015; Kesmodel et al., 2003; McDonald et al., 2014; Mullally et al., 2011; Niclasen, 2014; Strandberg-Larsen et al., 2008; Tran et al., 2015). **In the studies that examined both light/moderate and heavy/binge groups, rates of smoking were higher among binge/heavy than light/moderate drinkers** (Cameron et al., 2013; Flynn et al., 2003; Mullally et al., 2011; McDonald et al., 2014). Dumas et al. reported a higher odds ratio in the binge drinking group (OR 4.3, 95%CI =2.22-8.63) than the moderate drinking group (OR 3.3, 95%CI 1.89-5.76).

Another frequently reported factor associated with heavy/binge drinking in pregnancy was being a single-parent or previously married (Cameron et al., 2013; Coathup et al., 2017; Flynn et al., 2003; McDonald et al., 2014; Mullally et al., 2011; Strandberg-Larsen et al., 2008; Tran et al., 2015). **Whilst this observation was also associated with light/moderate drinking, it was stronger in the binge/heavy group. For example, Mullally et al. (2011) reported an eleven-fold increase in the odds ratio associated with the likelihood of single women becoming light/moderate drinkers in pregnancy.** There is some evidence that **heavy/ binge drinkers were more likely to be younger rather than older women** (Cameron et al., 2013; Flynn et al., 2003; Gladstone et al., 1997; Göransson et al., 2003; McDonald et al., 2014; Mullally et al., 2011). **For example McDonald et al., reported that binge drinking women were more likely to be younger than 24 years old when compared with women over 35 (OR 4.28 CI=2.58-7.09.). Heavy/binge drinking was also associated with** unemployment (Strandberg-Larsen et al., 2008), lower income (Coathup et al., 2017; Flynn et al., 2003; McDonald et al., 2014; Tran et al., 2015), or low level of education (Cameron et al., 2013; Coathup et al., 2017; Flynn et al., 2003; McDonald et al., 2014). Heavy/binge drinking was also associated with nulliparity (Iversen et al., 2015;

Kesmodel et al., 2003; McDonald et al., 2014; Mullally et al., 2011) and with an unintended/unplanned pregnancy (Dumas et al., 2017; Ethen et al., 2009; Iversen et al., 2015; McDonald et al., 2014; Mullally et al., 2011; Strandberg-Larsen et al., 2008). Of the six studies that observed association between binge drinking and unintended pregnancy, Strandberg-Larsen et al. (2008) was the only study to specify this association in the post-pregnancy recognition.

Binge/heavy drinking during pregnancy was positively associated with pre-pregnancy drinking in six studies (Alvik et al., 2006; Ethen et al., 2009; Iversen et al., 2015; Göransson et al., 2003; McDonald et al., 2014; Strandberg-Larsen et al., 2008). Ethen and colleagues (2009) found that women who binge drank in the three months before pregnancy were much more likely to binge during pregnancy, compared to abstainers. McDonald et al. (2014) found that women who binge drank in the previous 12 months before pregnancy were much more likely to do so during pregnancy than women who did not binge pre-pregnancy (OR 15.29, 95%CI=9.59, 24.35). This was stronger than the association they found between pre-pregnancy binge drinking and light/moderate drinking during pregnancy (OR 2.91, 95%CI 2.42, 3.51).

Women whose health professionals inquired about drinking in pregnancy during the prenatal care were also associated with heavy/binge drinking in Flynn and colleagues' study (Flynn et al., 2003). Substance use was found to be associated with heavy/binge drinking in three studies (Cameron et al., 2013; Gladstone et al., 1997; Mullally et al., 2011).

There is also some evidence that women with mental health problems are at risk of heavy/binge drinking (Niclasen, 2014; Strandberg-Larsen et al., 2008). This includes women with high levels of anxiety (McDonald et al., 2014; Tran et al., 2015), depression (Coathup et al., 2017; McDonald et al., 2014) and who had experienced greater number of adversities in life (McDonald et al., 2014; Tran et al., 2015). Satisfaction with life was negatively associated with heavy/binge drinking in Alvik and colleagues' study (2006) as was dispositional optimism (McDonald et al., 2014).

Insert Table 2 here

DISCUSSION

The aim of this review was to identify factors associated with patterns of alcohol use during pregnancy. Fifteen articles were identified, in which seven explored light/moderate drinking and all investigated heavy/binge drinking. Despite heterogeneity in the methods and analysis of studies included, a number of factors were identified to be associated with drinking patterns. These include demographic characteristics of the mothers (i.e., age, income) and pregnancy characteristics (i.e., parity). Relatively few studies have looked at the association between drinking patterns and psychological and contextual characteristics of the women including maternal mental health, motivational reasons for drinking, self-regulation and levels of social support available during the prenatal care. While there is an extensive body of literature on alcohol and pregnancy, the inconsistent classification of drinking patterns (i.e., including heavy and light drinking in the referent group) limited the inclusion of studies in this review. Also noticeable in this review was the dearth of studies exploring light/moderate drinking in pregnancy. Given that the impact of light/moderate drinking on the fetus is not fully understood (Mamluk et al., 2017) it is possible that the literature concerning factors associated with drinking in pregnancy may be biased in favour of examining heavier drinkers, as they are the most at risk group. Nevertheless, light/moderate drinking is more prevalent than heavy/binge drinking in pregnancy (Callinan and Room, 2010; O'Keeffe et al., 2015), so this is a specific area of need for future research.

Reporting the overall effects of each factor on drinking patterns was not possible for each study given the heterogeneity in the statistical approaches across studies. Nevertheless, it is salient in this review that smoking was the most frequently examined and consistently reported factors associated with heavy/binge drinking during pregnancy. There was some

evidence that it was also associated with light/moderate drinking. Exposure to smoking in utero, like alcohol, can lead to numerous adverse health outcomes to the pregnancy, fetus and children. Our findings reinforce the need for dual targeting of smoking and alcohol cessation during the antenatal care, following a woman's indication of either behaviour (Oh et al., 2017).

Research suggests that by reducing the fetus' exposure to the toxicity of other substances including smoking might also decrease the risk for FASD when alcohol was consumed in pregnancy (May & Gossage, 2011). Health professionals should also be trained to communicate with women who might use alcohol as a form of dealing with stresses and anxieties potentially generated by specific circumstances of life during the first pregnancy. The characteristics of the women such as age, marital status and pregnancy intention must be recognised in these interventions.

Sufficient evidence does not exist to determine whether maternal psychological characteristics are associated with light/moderate drinking. However, five of the fifteen studies that explored heavy/binge drinking found that mental health problems including anxiety and depression were associated with drinking during pregnancy (Coathup et al., 2017; McDonald et al., 2014; Niclasen, 2014; Strandberg-Larsen et al., 2008; Tran et al., 2015). Previous studies have reported an association between poor mental health (Peltzer and Pengpid, 2019; Skagerström et al., 2011), traumatic experiences (Choi et al., 2014), and exposure to violence and drinking in pregnancy. Possible explanations for these associations lie on the use of alcohol as self-medication attempting to alleviate symptoms of trauma, anxiety, and depression, and increase feelings of autonomy and control. The complex mental health profile that characterises many women who drink heavily has proved to be a barrier to changing drinking behaviour in interventions aimed at curbing drinking in pregnancy (Per, 2009; Valiesquez et al., 2010). Further studies are needed to increase understanding of the association between psychological factors and patterns of drinking during pregnancy, and how health professionals might support

women in this context. Randomised control trials of psychoeducational and case management interventions need to be performed on pregnant women who drink harmfully to help understand the best treatment approaches for these women (Lui, Terplan and Smith, 2008; May et al., 2013; State et al., 2009). These interventions must reflect the mechanisms by which behaviour change techniques support alcohol abstinence (Michie, Hyder and West, 2010) including how family and social factors (e.g, levels of social support, partner/family drinking), and psychological factors (e.g., personal risk perception, motivational factors, self-efficacy) might facilitate the delivery of successful interventions.

We found some evidence that women in the higher income groups were likely to drink light/moderate levels of alcohol. We also found some evidence that unemployed women with lower levels of educational attainment were likely to engage in heavy/binge drinking. The current evidence on the association between sociodemographic status and drinking in pregnancy is inconsistent. For example, some studies suggest that alcohol use in pregnancy is unrelated to sociodemographic status, whereas others show that women from higher income groups are more likely to consume alcohol during pregnancy than those in the lower groups (Anderson et al., 2013; Callinan and Room, 2010) . However, these studies did not consider different patterns of drinking when exploring possible associations. Our review overcomes this limitation and highlights the importance of looking at more refined definitions of alcohol consumption in studying sociodemographic influences of drinking in pregnancy.

Consistent with findings from Skagerstrom et al. (2011) review, we found that pre-pregnancy alcohol consumption was a strong factor for prenatal alcohol use. This association was particularly pronounced with heavy/binge drinking (Ethen et al., 2009; Iversen et al., 2015; McDonald et al., 2014; Strandberg-Larsen et al., 2008). **There is some evidence in this review on the association between unplanned pregnancy and heavy/drinking, especially before pregnancy recognition. Epidemiological studies show that drinking among women of**

childbearing age has increased (Slade et al., 2016). A large proportion of women are not aware of the pregnancy until they are well into the first trimester, especially those who were not intending to become pregnant (Floyd, Decoufle and Hungerford, 1999). Findings from this review emphasise the importance of psychoeducational interventions with women of childbearing age prior to conception to change their drinking habits and/or improve contraception.

Limitations

Studies that met the inclusion criteria of the review were included regardless of the methodological quality of the study and they all rely on self-reporting of alcohol consumption. Potential underreporting of alcohol use might have affected the associations in the observed factors. For example, if older and more socially advantaged women are less likely to report alcohol use, it would lead to an underestimate of the relevant factors associated with their drinking patterns. In addition, women might be reluctant to share potentially stigmatizing information about themselves. The use of objective measures such as biomarkers and physiological measurements in combination with self-report measures might improve methods of collecting maternal risk data (Litten, Bradley, Moss, 2010). The studies examined in this review differed significantly in terms of measuring alcohol intake, defining drinking patterns and the point of gestation at which data were obtained. For example, Dumas et al. (2017) defined binge drinking as consuming approximately 3 standard units, whereas most studies classified binge drinking as five or more standard units on a single occasion. International variation in the classification of binge drinking might reflect such differences (Wicki et al., 2010). Furthermore, it was observed by Ethen and colleagues (2009) that drinking patterns vary quite significantly throughout the course of pregnancy. Given the range of studies included in this review, it was not possible to separate the associations to determine if they were differences at different time points throughout pregnancy. This undoubtedly introduced a greater degree of heterogeneity to

our results. Future studies in this area should consider the whole gestational period when collecting data, rather than taking samples at limited time points.

A further limitation of this review is that we combined factors associated with binge drinking with factors associated with “heavy” drinking. Whilst these patterns may be similar, it is possible that the characteristics associated with the behaviours may differ, and grouping them together could have led to biased results. In a similar manner, we combined analysis of low and moderate consumption patterns. Again, whilst many of the characteristics of these groups may overlap, differences between low and moderate drinkers were described in at least one study (Dumas et al., 2017). Lastly, important evidence synthesis methods such as risk of bias appraisal and data extraction and analysis are lacking in this rapid assessment review. Given the relatively few published studies on drinking patterns in pregnancy and the limitations presented here, we would argue that the current evidence base is insufficient for full systematic reviews with meta-analyses to be undertaken.

Conclusion

The major conclusion from this review is that greater attention needs to be paid to gathering accurate and detailed data of a wide range of factors that could be related to patterns of drinking during pregnancy. In particular, specific attention needs to be given to psychological (e.g., mental health, risk perception, motivational reasons, self-efficacy) and contextual factors (e.g., levels of social support, partner/family drinking). Moreover, studies tend to not consider the full range of drinking behaviours during pregnancy, which is exemplified by the relative lack of articles examining the light/moderate group in our review. Further studies on factors associated with light/moderate drinking in pregnancy are required to provide further evidence. There is marked variation in how alcohol drinking is measured. In order for more robust and consistent research to be produced, the way in which alcohol measurements are applied should be standardised.

and studies should take into account the commonly observed variations in alcohol consumption throughout the course of pregnancy. Nevertheless, in this review of the literature, we found that smoking was a consistent factor associated with heavy/binge drinking in pregnancy, and higher income was most consistently associated with light/moderate drinking.

CONFLICTS OF INTEREST

All authors declare no conflict of interest.

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Table 1. Description of the studies: maternal factors associated with low/moderate drinking and high/binge drink in pregnancy (n=15)

Authors	Country	Participants	Aims	Design and Methods	Time during/after pregnancy when data was collected	Alcohol Measurement	Factors: Low/moderate drinking	Factors: High/binge drinking
Cameron et al., 2013	Australia	2731 pregnant women enrolled from 2007 to 2011 in the Griffith Study of Population Health. Modal age= 25-29 (796/2731=29%)	To describe the characteristics of women that partake in risky drinking patterns before pregnancy and to examine how these patterns change once they become pregnant.	Prospective longitudinal using self-reported questionnaire administrated in public maternity hospitals	T1= 0-13 weeks T2=14-26 weeks T3= 27-42 weeks	Alcohol intake was assessed using items from the 2004 National Drug Strategy Household Survey, Low= <2 Standard drinks on one occasion High risk = ≥5 SU on one occasion	Older age, higher education, higher income, smoking, illicit substance use	Younger age, lower education, single parent, smoking, illicit substance use
Tran et al., 2015	Australia	6597 pregnant women enrolled in the Mater-University of Queensland Study of Pregnancy. Modal age=20-24 (38%)	To determine trajectories of maternal alcohol consumption before and after pregnancy and predictors of these trajectories	Longitudinal prospective study using self-report questionnaire	T1= First prenatal visit T2=early pregnancy T3=18 weeks' gestational T3= 6 months post-partum	Alcohol consumption scores were estimated by multiplying frequency and quantity of alcohol consumption. Light drinkers (average less than a 1/2 glass per day), modest drinkers (1/2 to less than 1 glass per day) and heaviest drinkers (average 1 glass per day or more)	Married, had four or more children, experiencing low level of adversity	Low income, having a previous marriage, anxiety, experiencing high level of adversity, had one child,

Gladstone et al., 1997	Canada	3,238 pregnant women who sought counselling concerning fetal risk of exposure to binge drinking in the clinic (3800) and by telephone (19991) Mean Age=32 (SD=5)	To characterize pregnant women who engage in binge drinking and to identify other risk behaviour that these women engage in.	cross-sectional study	Whole pregnancy until contact	Binge= ≥ 5 Drinks on one occasion		Younger age, smoking and illicit substance use,
McDonald et al., 2014	Canada	2,246 pregnant women enrolled in The All Our Babies study. Modal Age= 25-34 (71.5%)	To identify predictors and maternal characteristics associated with different alcohol consumption patterns prior to and following pregnancy recognition	Longitudinal prospective study using self-reported questionnaire	T1 = <25 weeks T2 = 34 to 36 weeks T3 = 4 months postpartum	Frequency and quantity of alcohol consumption in the year before pregnancy and the periods prior to and subsequent to pregnancy recognition. Low levels: <1 drink per week. Moderate levels: ≤ 2 drink per week. High levels: 2 drinks per occasion per week or ≥ 3 drinks per occasion at any time. Binge Drinking: $\Rightarrow$ 5 or more drinks per occasion	Smoking, pre-pregnancy binge drinking	Younger age, lower levels of education and income, single, nulliparity, unplanned pregnancy, smoking and binge drinking prior pregnancy, experienced adversities, depression, anxiety and low dispositional optimism

Iversen et al., 2015	Denmark	2,246 pregnant women. Modal Age= 25-34 (71.5%)	To describe the prevalence of weekly alcohol consumption and binge drinking in early pregnancy among women living in the capital of Denmark. Secondly to identify pre-pregnancy lifestyle and reproductive risk factors associated with binge drinking during early pregnancy	Cross-sectional using self-reported online questionnaire	10 weeks	Quantity of alcohol consumed per week before and during pregnancy. Binge => 5 or more units on a single occasion		Unplanned pregnancy, primipara, smoking, higher quantity drinking before pregnancy
Kesmodel et al., 2003	Denmark	432 pregnant women. Average age not reported	To describe the frequency and pattern of alcohol consumption and the use of illicit drugs during early pregnancy	Prospective longitudinal study of women attending routine antenatal care. Initial interview conducted by researchers followed by a two-week self-reported daily diary on alcohol intake.	Initial interview: 15–16 weeks gestation Follow up: a diary completed during 2 consecutive weeks starting immediately after the interview.	Reports about alcohol intake before and during pregnancy of different types of beer, wine, fortified wine, spirits and alcopops. Current average intake in pregnancy was calculated on average of the two weeks (diaries). Binge= ≥60g on one occasion		Smoking, primiparous
Niclasen, 2014	Denmark	63464 pregnant women enrolled in the population-based Danish National Birth Cohort. Mean age = 30.5	To compare women who drink and who do not drink alcohol in pregnancy on a number of potential confounding variables	Retrospective cohort study using maternal self-reports on alcohol exposure	T1= week 16 T2= week 30 T3= 6 months post-partum	Weekly average intake of alcohol and binge episodes. Binge drinking: =>5 units alcohol on a single occasion		Mental health disorder, smoking,
Strandberg-Larsen et al., 2008	Denmark	85,334 pregnant women enrolled in the Danish National Cohort. Modal age= 25-29	To describe characteristics of Danish women who binge drank in the pre-and post-recognised part of their pregnancy	Prospective longitudinal study	T1= week 12 T2= week 30 T3= 6 months after delivery	Frequency of time of binge drinking (= ≥5 drinks in one occasion or evening) during the entire pregnancy		Unemployed, single, smoking, higher alcohol consumption before pregnancy, multiparity, unplanned pregnancy, mental disorder

Coathup et al., 2017	England	9839 women enrolled in the Avon Longitudinal Study of Parents and Children	To determine associations between maternal dietary patterns and alcohol consumption during pregnancy	Retrospective cohort study of data collected using self-reported questionnaires	18 weeks' gestation	Frequency and quantity of alcohol consumption Across 3-month period. Binge drinking: ≥ 4 standard units on at least one occasion in the past month		Lower levels of education and income, single, smoking, multiparity, depression
Dumas et al., 2017	France	3,603 women. Modal age= 30-34 (34.4%, N=1202)	Identify the prevalence of the population at risk and on the characteristics of women engaging in risky drinking in pregnancy	Cross-sectional study conducted via telephone interview among pregnant and postpartum women	2nd Trimester 3rd Trimester 1-3 months Post-Partum	light drinking ≤ 1 drink per month moderate drinking 2 to 4 drinks per month; high drinking ≥ 2 per week; binge= ≥ 30 g of pure alcohol in a single occasion	Older age, higher levels of education and income, nulliparity	Smoking, late pregnancy recognition
Mullally et al., 2011	Ireland	61,241 women who booked for antenatal care and delivered in a large urban maternity hospital	To investigate the prevalence, predictors and perinatal outcomes associated with periconceptional alcohol consumption.	Retrospective cohort study using the electronic booking records of women with singleton pregnancies	First antenatal visit, approximately 12 weeks' gestation.	Self-reported alcohol consumption at the booking visit was categorised as low (0-5 units per week), moderate (6-20 units per week) and high (>20 units per week)	In employment, single, smoking, nulliparity	Younger age, single, smoking, illicit drug use, nulliparity, unplanned pregnancy.
Alvik et al., 2006	Norway	1,749 pregnant women. Mean age=30.8 years (SD=4.4)	To estimate alcohol consumption and binge drinking before and during pregnancy	Prospective longitudinal using self-reported questionnaire administered during an ultrasound screening	T1=17 weeks T2= 30 weeks T3 = 6 months after term	T-ACE (screening for pregnancy risk drinking), frequency of alcohol use, Standard Units (SU) per occasion, SU/week, and binge drinking (≥ 5 SU per occasion)		Smoking during pregnancy, high frequency of alcohol use before pregnancy, lower levels of life satisfaction
Göransson et al., 2003	Sweden	1101 pregnant women receiving antenatal care and signing up for parental education programme	To examine the prevalence of hazardous or harmful alcohol consumption during pregnancy in a consecutive series of Swedish pregnant females.	Cross-sectional study using self-reported questionnaire	Typically, in pregnancy week 30.	Alcohol Use Disorders Identification Test (AUDIT). Low-risk pregnancy status: ≤ 1 drink consumption per month. High risk: ≥ 2 drink consumption per month	Older age, pre-pregnancy high quantity of drinking	Younger age, Pre-pregnancy high alcohol use

Ethen et al., 2009	USA	4,088 randomly selected control mothers from the National Birth Defects Prevention Study Modal age= 30-34 (1102/4088= 27%)	To determine the prevalence, patterns, and predictors of alcohol consumption prior to and during various intervals of pregnancy	Cross-sectional study conducted via an extensive computer-assisted telephone interview among women who delivered live born infants without malformations	Within 24 months after delivery	Questions about quantity of alcohol use during each of eight time periods: the 3rd, 2nd, and 1st month before conception; the 1st, 2nd, and 3rd month of pregnancy; and the 2nd and 3rd trimesters of pregnancy. Binge drinking = ≥ 4 drinks on one occasion		Smoking during pregnancy, pre-pregnancy drinking, unintended pregnancy
Flynn et al., 2003	USA	1131 pregnant women Mean Age= 28.7 (SD=5.3)	To demonstrate feasibility of screening and to identify rates and correlates of alcohol use in a large, demographically representative sample of pregnant women.	Cross-sectional study using self-reported questionnaire administrated during the waiting areas of eight obstetrics clinics in Michigan	At various stages of pregnancy, ranging from 3 to 41 weeks	TWEAK alcohol screener (direct and indirect measures of alcohol use) Low risk= <1 drink per week and no binge High risk= >1 SU per week and/or at least 1 binge episode	Older age, smoking	Younger age, lower levels of education, single, smoking, lower number of previous children, depression

Table 2. Maternal characteristics associated drinking patterns according to the frequency of reports
(N= number of studies)

Light/Moderate Drinking (N=7)	Heavy/Binge Drinking (N=15)
<i>Sociodemographic</i>	<i>Sociodemographic</i>
Older Age (N=4) Higher Education (N=2) Higher Income (N=2) In Employment (N=1) Marital Status Single (N=1) Married (N=1)	Younger Age (N=6) Lower Education (N=4) Lower Income (N=3) Unemployed (N=1) Marital status - single (N=7)
<i>Substance use</i>	<i>Substance use</i>
Smoking (N=4) Illicit substance use (N=1) Pre-pregnancy binge drinking (N=2) Physician inquiry about alcohol and pregnancy (N=1)	Smoking (N=13) Illicit substance use (N=3) Pre-pregnancy binge drinking/ high quantity (N=6) Physician inquiry about alcohol and pregnancy (N=1)
<i>Pregnancy</i>	<i>Pregnancy</i>
Parity (N=3) Nulliparity Multiparity	Parity (N=8) Nulliparity/ one or few previous children Multiparity
<i>Psychological</i>	<i>Psychological</i>
Low level of Adversity (N=1)	Depression (N=2) Anxiety (N=2) Mental health disorder (N=2) High number of adversity experiences (N=2) Low life satisfaction (N=1) Low optimism (N=1)

Supplement material. Main search terms used in the databases

Substance	Maternal	Associated
Alcohol use	Pregnancy	Factor*
Alcohol consumption	Pregnant	Epidemiolog*
Drinking behavior	Mother	Prevalence*
Risky drinking	Maternal	Characteristic*
Harmful drink*	Women	Predict*
	Gestation	Correlate*
		Pattern