Are psychosocial interventions effective in reducing alcohol consumption during pregnancy and motherhood? A systematic review and meta-analysis

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Abstract

Background and aims Alcohol use by pregnant and parenting women can have serious and long-lasting consequences for both the mother and offspring. We reviewed the evidence for psychosocial interventions to reduce maternal drinking.

Design: Literature searches of PsycINFO, PubMed, and Scopus identified randomised controlled trials of interventions with an aim of reduced drinking or abstinence in mothers or pregnant women. **Setting**: Interventions were delivered in healthcare settings and homes. **Participants**: Pregnant women and mothers with dependent children. **Interventions**: Psychosocial interventions were compared with usual care or no intervention. **Measurements**: The Revised Cochrane Risk-of-Bias Tool for Randomised Trials was used for quality assessments. Narrative synthesis summarised the findings of the studies with a subset of trials eligible for random-effects meta-analysis. General and alcohol-specific behaviour change techniques (BCTs) were identified to investigate potential mechanism of change.

Results: 24 studies were included (20 pregnancy, four motherhood). Due to quality of reporting, data from only six pregnancy and four motherhood studies could be pooled. A significant treatment effect was revealed by the meta-analyses of pregnancy studies regarding abstinence (OR = 2.31, 95% CI = 1.61, 3.32; P < 0.001) and motherhood studies regarding a reduction in drinking (SMD = -0.20, 95% CI = -0.38, -0.02; P = 0.03). Narrative synthesis of the remaining trials yielded inconsistent results regarding intervention effectiveness. A wide range of BCTs were employed, present in both effective and ineffective interventions. The most commonly used general and alcohol-specific BCTs included information about consequences, social support, goal setting, and action planning. **Conclusions:**In pregnant women identified as consuming alcohol, psychosocial interventions appear to increase abstinence rates compared with usual care or no intervention. Similarly, such interventions appear to lead to a reduction in alcohol consumption in mothers with dependent children. It is unclear which BCTs are contributing to these effects. Conclusions from RCTs are only meaningful if the behavioural outcome, population, setting, intervention, and comparator are clearly reported. An important barrier when it comes to identifying effective BCTs is a widespread failure to provide enough information in study reports.

Keywords Behaviour change, randomised controlled trials, pregnancy, motherhood, postpartum, maternal drinking, abstinence, reduction, alcohol reduction interventions.

Introduction

Prenatal alcohol use is the dominant preventable cause of birth defects and intellectual disabilities (1). As a safe amount of alcohol consumption during pregnancy is unknown, the most recent government recommendation for the UK (2), and most other countries (1), is abstinence. Yet, the UK has one of the highest rates of reported alcohol use during pregnancy and highest levels of Foetal Alcohol Spectrum Disorders (FASD) globally (3).

Due to the direct and significant effects of prenatal alcohol exposure on the offspring, the focus of policy and research remains primarily on drinking during pregnancy (4). However, evidence shows that alcohol use spanning early to later motherhood is also a significant public health concern, one that can directly and indirectly damage the mother and child's health and well-being even at non-dependent level (5). Parental drinking can negatively impact the child-rearing environment (e.g.(6)), and maternal drinking in particular can increase physical (7) and psychological (e.g. (8)) harm in the child, damage the mother-child relationship (e.g. (9)), and increase the risk of alcohol-related problems later in life (e.g. (10)). Therefore, it is critical to develop appropriate alcohol interventions and support for pregnant women and mothers to help reduce these harms.

Research demonstrates that pregnancy and the transition to motherhood, once considered a protecting factor against drinking (11), no longer have a lasting impact on alcohol consumption (12). Within the UK, the Avon Longitudinal Study of Parents and Children found that 16.4% of mothers reported drinking alcohol on a daily basis (13). Other cohorts have shown that any protective factor against alcohol use has diminished by 12 months postpartum (12). Another report estimated that up to 1.3m children were affected by parental alcohol problems in England (14). This suggests a growing need for alcohol interventions which are effective during pregnancy and motherhood to help prevent longer-term consequences.

Understanding active components of treatment/mechanisms of change may enhance the development of effective treatments or aid in the identification of what treatments work best for different populations (15). The BCT Taxonomy v1 (BCTTv1), a cross-domain, hierarchically structured classification, has identified 93 distinct general Behaviour Change Techniques (BCTs; the smallest active components of a behaviour change intervention) (16), and separate categorisation has been made of 42 alcohol-specific BCTs (17). Although certain BCTs are associated with effectively reducing alcohol consumption (e.g. 'prompting self-recording' (17), 'provision of normative feedback' (18), 'providing feedback on performance',

'review of goals', 'prompting commitment' (18)), this evidence comes from non-maternal populations. During pregnancy, Fergie and colleagues (19) identified 13 potentially effective BCTs for the reduction of alcohol use, five of which were classified as highly effective: 'action planning', 'behavioural contract', 'prompts/cues', 'self-talk', and 'offer/direct toward appropriate written material'.

Although systematic reviews have looked at interventions for illicit substance use specifically in mothers (e.g.(20)), there are no reviews on the effectiveness of alcohol interventions. Given the direct and indirect impact of drinking during pregnancy and motherhood, we argue that research on maternal drinking needs to cover this wider time period. This review is unique in its aims to provide a comprehensive review, highlighting the effectiveness of alcohol interventions for pregnant women and mothers and identifying potentially appropriate BCTs in reducing maternal alcohol consumption by reviewing randomised controlled trials (RCTs) with active or inactive controls. We also examine how the more developed field of research concerning alcohol use during pregnancy may guide future research on drinking during motherhood. We aimed to address the following questions: 1) What type of interventions have been used to reduce drinking during pregnancy and motherhood? 2) Are these interventions effective? 3) What BCTs are used in effective interventions?

Methods

Protocol and registration

Conducted and reported according to PRISMA guidelines (21, 22), the present review was pre-registered at the International Prospective Register of Ongoing Systematic Reviews (PROSPERO; (23)). Registration ID number: CRD42019132035.

Information sources and search strategy

The initial literature search of the electronic databases PsycINFO (via EBSCO Host), PubMed, and Scopus was conducted in May, 2019 and updated in February 2020, to identify RCTs assessing effectiveness of interventions aimed at reduced alcohol use or abstinence in pregnant women or mothers. To cover potential synonyms for the terms used, databases' own "MeSH" terms, Thesaurus, or subject headings were used to choose the key terms. Using the Boolean operators AND/OR, population terms were combined with behaviour terms and treatment terms and were adjusted to each database (Table 1).

Insert Table 1

Eligibility criteria

The search was limited to peer-reviewed journals without time restriction. Only RCTs comparing the effectiveness of an alcohol intervention against a control group, with pre- (baseline) and post-drinking outcomes, were included. The review focused only on interventions that targeted alcohol use with an alcohol-related outcome measured and reported (even if polysubstance use was present). For maternal characteristics, studies could include pregnant women and mothers with children of dependent age (≤ 18 years) (see Supplemental document Table 1 (ST1) for full eligibility criteria).

Study selection and data extraction

KUG performed the database searches, and KUG and LJ screened titles, abstracts, and full texts independently. Full texts were acquired for papers eligible for inclusion. The PRISMA flow diagram (Figure 1) demonstrates the article search process. Reference lists of included studies were searched by KUG and LJ. Agreement statistics were calculated for full-text screening. Inter-rater agreement was 80.7%, with Cohen's k=0.524, indicating moderate agreement (24). The following study characteristics were extracted by KUG and reviewed by LJ: bibliographic details (authors, year), sample size(s), PICOS, and follow-up period. Resolution for any discrepancies were provided by AR. Additionally, the following data characteristics were considered for the meta-analysis: type of data (binary, continuous), time frame of measuring outcome, outcome measured (abstinence, reduction in alcohol consumption), baseline alcohol intake, age, intervention type, and whether a significant difference was found between treatment arms.

Quality assessment for risk of bias

Quality assessment of the included studies was performed by KUG and reviewed by LJ using the Revised Cochrane Risk-of-Bias Tool for Randomised Trials (RoB2; (25)) and the RoB2 tool for cluster randomized parallel group trials (26) addressing five domains. AR reviewed the assessment of a sub-set of the studies. There were no disagreements.

Data analysis

For inclusion in the meta-analyses, we required summary statistics (mean, standard deviation) for frequency and quantity of drinking following intervention for treatment and control groups. Corresponding authors were contacted for missing data and provided a period of one month to respond (reminders were sent). Following receipt of additional data from some authors (27, 28), six trials were sufficiently similar to combine (i.e. outcome (abstinence for pregnancy, reduction for motherhood), comparable timeframe, baseline alcohol use). In line with government guidelines (abstinence recommended during pregnancy and no more than 14 units a week for the general population), these outcomes were deemed practical for the purposes of the meta-analyses (see ST2 and ST4 for details).

A narrative synthesis enabled the integration and summary of the results, and a qualitative content analysis (inductive in approach) examined the process evaluation of included RCTs. Content analysis was performed by KUG via (1) familiarisation with process evaluation descriptions within each article, (2) highlighting relevant text and memo writing to capture authors' views on factors likely to have influenced RCT efficacy, (3) grouping reoccurring process evaluation factors into defined categories, and (4) labelling defined categories. Credibility of the overall coding structure was enhanced by returning to the data and ensuring that the categories represent the data as a whole (29). AC additionally reviewed the analysis process and categorisation to increase trustworthiness (30).

Results of studies with sufficiently similar data to calculate a common estimate were pooled in a random-effect meta-analysis conducted in RevMan version 5.3 (31) (data are available here: https://osf.io/cteug/). For rates of abstinence, odds ratios were calculated using the total number of abstinent participants at follow-up and the total number of participants randomized to that intervention/control group. A common timeframe used was three months follow-up for abstinence in pregnancy and six-month for alcohol reduction in motherhood. For continuous measurements of reduction in alcohol consumption, we computed the standardised mean difference (SMD: $\text{Intervention}^{\text{MEAN}} - \text{Control}^{\text{MEAN}}$ / Pooled SD) to correct for differences in scales and standardise the results.

One study (32) investigated the effects of two interventions (health counselling and computer tailoring) compared to the same control group, therefore, it was added twice. To partially remove the unit-analysis-error this may lead to (55), both the events and total number of participants were divided.

I^2 statistics of heterogeneity were calculated (33). A heterogeneity of 0-40% represents low, 30-60% moderate, 50-90% substantial, and 75-100% high variability in effect sizes (34).

Identification of BCTs and theory

The BCTTv1 (93 general BCTs) (16) was employed with the 42 alcohol reduction specific BCTs (17) to identify BCT content. Although there is overlap between the two taxonomies, they were identified and reported separately, enabling the identification of BCTs with less specific descriptions (a common issue in reports). Prior to coding BCTs, coders completed online training in BCT identification (35). Authors were contacted for additional intervention material to aid BCT identification. KUG identified text in the reports of included studies, previously conducted cited studies, and intervention manuals/additional materials. AR, AC and LJ checked accuracy of BCTs in randomly selected subsets of trials. We collected BCTs and considered them potentially useful for inclusion in future interventions if 1) the primary analysis revealed statistically significant differences at the 5% level between treatment arms in favour of the intervention group, 2) there was detection of apparent benefits of the intervention at some level (e.g. if the intervention benefitted those with higher level drinking).

Reports were screened for incorporation and description of theory relevant to the intervention methods used. KUG evaluated the incorporation of theory into the design and implementation of the interventions through a four-item coding continuum (informed by theory, theory applied, testing theory, building/creating theory (36)). Due to the evidence-based theoretical background of motivational approaches and CBT, studies that used these techniques were classified into the category of 'informed by theory' despite failing to report this. AR and LJ checked accuracy of identified theory use in randomly selected subsets of trials.

Results

Study selection

8390 papers were identified through database searching and two papers through other sources. Of these, 1306 duplicates were removed. Following title and abstract screening, 6972 were eliminated. Full texts of 114 articles were assessed of which 90 were excluded (data on excluded papers are available here: (data are available here: https://osf.io/cteug/). Twenty-four

trials were included in the narrative synthesis, 10 of which were analysed through two meta-analyses (six pregnancy, four motherhood; see Figure 1).

Insert Figure 1

Characteristics of pregnancy studies (see Table 2 and ST2 for full characteristics)

Most studies were conducted in the USA and published between 2005-2019, with four published between 1982-1999. Sixteen trials (37-52) were individual RCTs, and four were cluster trials (27, 32, 53, 54). A total of 8467 participants were involved with a wide range of study samples between 41 and 2235 participants, covering low levels of alcohol consumption (e.g. 1 standard drink of alcohol p/week during pregnancy (32)) to heavier/problematic drinking. Most participants were aged 18-37 years. Ethnicity of participants differed considerably across the studies. The studies measured outcomes at different time periods between 2 weeks and 60 months. All studies employed self-report measures, and one trial used an additional segmental hair analysis (48). Six pregnancy studies provided sufficiently similar data to be pooled in a meta-analysis in terms of baseline alcohol intake, intervention outcome, comparable timeframe (32, 47-51).

Our aim to determine the types of interventions used to reduce maternal drinking highlighted a wide range of approaches. The majority, 12 trials, investigated the effectiveness of brief interventions (BIs) (27, 38-43, 45, 48, 49, 52, 53). Eight of these were underpinned by motivational approaches (40-43, 45, 48, 49, 52), one by social learning theory (27), and three by self-determination theory (42, 43, 49) (see ST3 for theory identification in studies). Other studies investigated the effectiveness of home visits (37, 54), public health intervention (47), ultrasound feedback (44), cognitive behavioural self-help intervention (50), health counselling and computer tailoring (32), information and advice provision (46), and motivational enhancement therapy coupled with cognitive behaviour therapy (CBT) (51). Three of the interventions were technologically delivered (32, 45, 49). Seven studies reported both reduction and abstinence outcomes (27, 32, 45, 49, 50, 52, 54), five focused on abstinence (37, 40, 47, 48, 51), and eight on reduction (38, 39, 41-44, 46, 53). Eleven studies utilised inactive controls (treatment as usual or no intervention) and nine used active controls (assessment only, providing information/education/advice/referral, or comparison interventions).

Insert Table 2

Characteristics of motherhood studies (see Table 3 and ST4 for full characteristics)

All were individual RCTs (28, 55-57) conducted in the USA in 2008 and onwards. The total number of participants recruited was 536 mothers with dependent aged children residing with the mother. The study samples ranged between 60-235. Participants in one study had substance use disorder (28), two involved high risk drinkers (55, 57), and one recruited problem drinkers (56). With the exception of one study (55), which recruited a diverse sample, all studies included mothers of low socioeconomic status with a majority of black ethnicity. Participants were aged 18-41 years. The timeframe for measuring outcomes covered periods between three and 18 months using self-report measures. All interventions were informed by theory (ST 3) and targeted a reduction in drinking through different approaches. Types of interventions used were an ecologically-based treatment (comprising housing services, case management and counselling (28)), BI (55), computer-delivered screening and BI (57), and social-cognitive behavioural intervention (56). Control conditions were usual care or no intervention, with one study employing an active control group (56). All trials reported sufficient data for inclusion into meta-analysis.

Insert Table 3

Risk of bias assessment

The assessment of methodological quality based on Cochrane's RoB2 (25), revealed poor quality of included studies for both pregnant and child-rearing populations. Although studies varied across quality measures, there was an overall high risk of bias primarily due to a lack of blinding, objective measures, and pre-specified analysis plans. When considering the quality of the evidence, it should be noted that the poor outcomes may be partly driven by factors common to psychological intervention studies (e.g. difficulties with blinding or the use of subjective measures) (for a full breakdown of trial quality, see Table 4).

Insert Table 4

Intervention effectiveness in pregnancy

Six of the 20 pregnancy trials were appropriate for meta-analysis with one of these studies (32) partially supporting intervention effectiveness. Of the remaining 14 studies, ten provided inconsistent findings in terms of BI effectiveness in pregnant women and four evaluated other types of interventions (37, 44, 46, 54). Below is a more detailed explanation of these studies.

Marais and colleagues (2011) found that drinking was reduced in the BI intervention group compared with the assessment only (AO) group, and another found that those allocated to a BI group were five times more likely to be abstinent by the third trimester relative to AO (27). The remaining studies found no significant overall treatment effect of BIs over control. However, when investigating further, three trials (38, 40, 41) revealed some beneficial intervention effects, e.g. benefits were seen in heavier drinking participants. One trial (54) investigated home visits by 'paraprofessionals' (i.e. mentor mothers). The three remaining RCTs were over 20 years old and used a variety of intervention types: professional home visits to provide health education (37); high versus low feedback ultrasound (44); and written information coupled with physician advice and a video (46). None of these studies found a significant effect on drinking during pregnancy.

Intervention effectiveness in motherhood

Fleming et al (2008) demonstrated intervention effectiveness using a multiple session BI for high-risk drinking, whereas a single-session BI (57) was ineffective. This is consistent with findings in favour of multiple sessions versus a single session in pregnancy (27, 41, 48, 52, 53) but contradictory to some findings that single-session interventions may work better for heavy drinking pregnant women (38, 40). Additionally, a 'control' single-session BI reduced alcohol consumption to a similar level compared to an 'active' cognitive-behaviour intervention based on CBT and motivational approaches (56). One trial included substance use counselling for homeless mothers while focusing on the impact of housing on substance use and found this intervention effective (28).

Factors impacting intervention effectiveness

The content analysis of the process evaluations within individual RCTs identified five categories reflecting factors that may have impacted the effectiveness of the interventions, resulting in conflicting findings.

Level of alcohol use: The level of alcohol risk and consumption varied among studies (see Table 2*)*. Motivational approaches and BI were found to reduce drinking in those with highest

drinking levels only (38, 40) in line with previous findings that these approaches work best with heavy drinkers who do not necessarily satisfy criteria for dependence (58). Additionally, low levels of alcohol use or high rates of abstinence at baseline leave little room to demonstrate intervention effect (42, 43, 52, 54).

Readiness to change: Low consumption level may be due to the strong motivating effect of pregnancy to change health-related behaviours (27, 43, 52), and the fact that motivated women are more likely to participate in an intervention (38). Motivational interviewing (MI) may be most effective with people who are less motivated, more resistant to change, and who are not ready to set goals. This raises concerns regarding the relevance of traditional motivational approaches with pregnant women, as they are often highly motivated to change and set abstinence goals (49).

Intervention dosage: Six of the ten studies used single-session MI or BIs (38-40, 42, 43, 45) and four tested multiple sessions (27, 41, 52, 53). Although, single-session interventions can be effective in heavy drinkers (38, 40, 58), there is no clear evidence specific to pregnant women. Indeed, multiple sessions may be more effective (27, 41, 53), especially for lower drinking populations (42, 43) due to the repetition of the message (48).

Underreporting: It is well-established that self-reported alcohol use can be misleading (59), especially in heavy drinking populations(60). In maternal groups, underreporting may be driven by social desirability bias (45, 52), recall bias (48), mistrust within clinical settings (53), and fear of consequences (43). Self-report measures may not, therefore, be adequate to identify those needing interventions and/or the effectiveness of interventions. Some studies used objective biomarkers in order to overcome the bias from self-reports of alcohol use (54) and contextual influences on its collection, such as hair segment analysis. A high level of underreporting in self-report measures was found compared to the more objective hair segment analysis (48).

Contamination of intervention: Eight studies found reduction in drinking irrespective of condition (27, 38-42, 45, 53). Women in control groups may have reduced their drinking due to the assessment alone or recognition of pregnancy (42, 43, 45, 52). Finally, if intervention provision and other study processes involve the same professional provider, qualities and learned behaviours may cross over the two conditions (43).

Meta-analyses

Abstinence in pregnancy

Abstinence data were available for six trials investigating the effects of alcohol reduction interventions, versus control, on abstinence during pregnancy. The studies randomised a total of 1031 participants and reported data for abstinence on 682 participants. The odds of achieving abstinence were 2.31 times higher in the intervention groups compared with control groups (OR = 2.31, 95% CI = 1.61, 3.32; Z = 4.54, P < 0.001, I^2 = 0%). See Figure 2.

Insert Figure 2

Alcohol reduction in motherhood

Four RCTs investigated the effectiveness of an alcohol reduction intervention on decreasing consumption in motherhood. A total of 536 participants were randomised at baseline and data for frequency of drinking days were reported for 487 participants. The test of overall effect revealed a small but statistically significant difference in favour of the intervention groups (k = 4; SMD = -0.20, 95% CI = -0.38, -0.02; Z = 2.15, P = 0.03, I^2 = 0%). See figure 3.

Insert Figure 3

Identification of BCTs

The final aim of the review was to identify BCTs used in effective interventions. Additional materials were made available by five authors (27, 28, 49, 50, 57). The interventions included both general and alcohol specific BCTs with some overlap among the classifications. These were identified and reported separately. One study (44) used low versus high feedback ultrasound as an intervention without reporting any BCTs.

Pregnancy studies (see ST5 for all BCTs identified and frequency of use and ST6 for unutilised BCTs): Out of the possible 93 general (16) and 42 alcohol-specific BCTs (17), a total of 36 general BCTs and 28 alcohol-specific BCTs were identified in 19 pregnancy studies. The most commonly used general BCTs were *3.1 'Social support (unspecified)'*, *5.1 Information about health* consequences', 1.*2 'Problem solving'*, *1.1 Goal setting (behaviour)*', and *1.4 'Action planning'*. The most commonly used alcohol-specific BCTs were *1. Provide information on consequences…'*, *14. Facilitate goal setting'*, *26. 'Advice on/facilitate social support'*, *15.*

'Facilitate action planning/help identify relapse triggers', and *21. 'Facilitate barrier identification and problem solving'*.

Motherhood studies (see ST7 for all BCTs identified and frequency of use): Twenty-seven general BCTs and 22 alcohol-specific BCTs were identified in the four motherhood trials. *1.1 'Goal setting (behaviour)'*, *3.1 'Social support (unspecified)'*, and *14. 'Facilitate goal setting'* were used in all four studies, while *1.2 'Problem solving'*, 6.*2 'Social comparison'*, *1. Provide information on consequences…'*, *4. Provide normative information…'*, *5.'Provide feedback on performance'*, *19. 'Facilitate relapse prevention and coping'*, and *26. 'Advice on/facilitate use of social support'* were identified in three of the studies.

BCTs in effective interventions for pregnant women and mothers

To identify BCTs with potential to reduce maternal alcohol use, 'effective' interventions were classified into two groups: effective (when the primary analysis reached statistical significance) and partially effective (when only secondary analysis reached significance or the hypothesis was partially supported. Table 5 provides details on these interventions and included BCTs. Some trials stated that interventions/BCTS were tailored to pregnancy and motherhood (e.g. Information about health consequences (55)). However, many intervention descriptions were brief, making the relevance of some BCTs to this population unclear (e.g. (56)).

Two pregnancy studies (27, 53) demonstrated intervention effectiveness. However, due to limited information, BCT identification in the study by Marais and colleagues (2011) was restricted. Additional material was received from O'Connor and Whaley (2007) aiding BCT identification. Two other studies found that their interventions appeared to be beneficial for reducing alcohol consumption in high level drinkers only (38, 40), one study (41) found reduction at 12-month follow-up but not in the active study phase, and one study (32) found their computer-based intervention partially effective. Across these six studies, a wide range of BCTs were employed but most frequent were: *3.1 'Social support'*, *5.1 'Information about health consequences'*, *1.1 'Goal setting'*, *1.2 'Problem solving'*, *8.2 'Behavioural substitution'*, *26. 'Advice on/facilitate use of social support'*, *1. 'Provide information on consequences of excessive alcohol consumption…'*, *5. 'Provide feedback on performance'*, *14. 'Facilitate goal setting'*, and '*17. Behaviour substitution'*.

Two of the motherhood studies (28, 32, 55) demonstrated intervention effectiveness independently. Both applied *1.1. 'Goal setting'*, '*3.1 Social support (unspecified)'*, *5.1 'Information about health consequences'*, *1. 'Provide info on consequences of excessive alcohol consumption…'*, and '*14. Facilitate goal setting'*.

Insert Table 5

Discussion

Using meta-analyses and a narrative synthesis, we sought to identify whether behaviour change interventions were effective in reducing maternal alcohol consumption (pregnancy or motherhood). Meta-analyses of pregnancy and motherhood RCTs revealed an overall significant effect in favour of the intervention groups in achieving abstinence and reduced drinking, respectively.

Several reviews, with different inclusion criteria, have been conducted focusing on drinking during pregnancy and all highlight that limited evidence exists regarding intervention effectiveness (1, 61-65). This is despite the fact that pregnancy is a critical period of intervention for alcohol reduction/abstinence due to women's motivation to have a healthy baby (1). The present review echoes this conclusion. Although a meta-analysis revealed overall intervention effectiveness, this only included six trials. Further, only two of the remaining 14 studies, without meta-analysis data, found significant differences in favour of the intervention. Research targeting alcohol use in motherhood is scarce. Although intervention effectiveness in mothers was demonstrated in our meta-analysis, both the number of studies included and the effect found was small. There was also no consistency across the interventions assessed, therefore these findings should be interpreted with caution. While brief alcohol interventions have been found effective in primary healthcare (63, 66), women in general, and with pregnant women in particular (67), it is not possible to draw a definite conclusion with regard to pregnancy or motherhood based on the evidence identified by this review.

In line with the literature (e.g. (66)), the findings of this review suggest that BIs may be more beneficial for heavier drinkers (38, 40), although signposting those dependent on alcohol to specialist services has been emphasised (66). Such findings may be the result of difficulties with demonstrating intervention success with lower level drinkers (67), attributable to high initial motivation by women to have a healthy pregnancy, and reactivity to the therapeutic

elements of screening and assessment (27, 42, 43, 52, 63). Previous research reveals a weak link between dosage of intervention and outcome (66). Despite a positive tendency for single-session BIs to influence heavy drinking (38, 40), and a proposition that multiple sessions have more potential for lower level drinking (27, 41-43, 53), the optimal length and frequency of BIs remain unclear (63). Further investigation is necessary into factors such as sample characteristics, type of BI, or mandate to treatment.

Previous research has identified some BCTs (e.g. self-monitoring) as effective in reducing alcohol use, including at moderate consumption levels (18). Yet few of the maternal interventions included these (50, 55). Evidently, more research is needed to identify effective maternal alcohol interventions and their active components. We would encourage using the more extensive BCT evidence in the pregnancy smoking literature which identifies providing incentives (68, 69), social support (e.g. from partner), and reducing negative emotions (70), to guide future work. For instance, pregnancy (71) and motherhood (72) can be a stressful time and alcohol can be used as a coping strategy (e.g. (73)). Yet 'reducing negative emotions' was only found in two pregnancy (37, 50) and two motherhood interventions (28, 56). This BCT could be utilised more to increase the effectiveness of interventions.

There is room to better incorporate and test theory in the design and assessment of maternal alcohol interventions (74).We would also encourage researching mode of delivery, as delivery and process-related factors may account for more variance than the BCT model. For instance, there has been an increase in interventions delivered digitally (75), but these tend to target easy-to-reach-populations while disregarding vulnerable groups, such as pregnant women (75). Only one study used this mode of delivery, and it successfully reduced alcohol consumption among pregnant women compared to control (32). It is possible that an online platform could help overcome underreporting of stigmatised behaviours (e.g. alcohol use), reach women who are not motivated to change, target lower drinking levels, improve efficiency in busy clinical settings, and take advantage of its flexibility (e.g. ease of implementation and alteration) (32, 45, 49, 57). Cost-effectiveness is another encouraging factor (76).

It is important to note discrepancies between our syntheses and that of previous reviews in this area (19, 64, 77). Our approach was more stringent - in accordance with good research practice, we based effectiveness on the study's primary analysis (78). Discrepancies may also have arisen due to unclear reporting (e.g. (40)). Without transparent presentation of results and greater specificity of intervention composition, it was not possible to determine what BCTs

may be beneficial for maternal alcohol reduction. An examination of overlapping BCTs used in effective/partially effective interventions did not produce robust recommendations. For example, the most frequently occurring BCTs in effective studies (e.g. goal setting) were also the most common in non-effective interventions.

We identified substantially more research focused on drinking during pregnancy relative to motherhood, a reflection of the direct harm drinking can have on the foetus (e.g. FASD). In the UK, only two RCTs were conducted with pregnant women 30 years ago (44, 46) and no RCTs with mothers. The lack of diversity in study samples suggest that mothers of higher socioeconomic status with subthreshold drinking may be overlooked. Pregnancy research highlights essential consideration of level of drinking, readiness to change, risk of taking up old, unhealthy behavioural habits, and appropriate motivators to stop drinking after pregnancy.

Limitations of this review are mainly associated with the available evidence base. The low number of studies limited our ability to assess publication bias and perform sensitivity analysis and meta-regression. Once a stronger evidence base is established, meta-regression could be used to determine whether any individual BCT or a combination of BCTs are associated with intervention effectiveness. For instance, there is some evidence from nonmaternal populations that control theory congruent BCTs (goal setting, self-monitoring, feedback, review goals, and action planning) work effectively when combined (79). Findings should be viewed while reflecting on the considerable bias detected in studies. However, the relevance of current quality assessment tools should be reconsidered, as psychological trials differ from medical studies in many aspects that might influence quality assessment (78). We employed the latest risk of bias measure recommended by Cochrane (RoB2) (25). However, its reliability in the context of assessing RCTs of psychological therapies is questioned (80), and more work is needed to determine whether the RoB2 is appropriate for psychology-related trials. Nevertheless, future RCTs should implement appropriate blinding procedures, the use of more objective measures, the importance of clear, systematic reporting, and the reporting of sufficient meta-analysis data.

For a number of reasons, the data summarised in the narrative synthesis do not provide sufficient evidence to determine the effectiveness of pregnancy alcohol interventions. These include the variety of interventions used, differences in drinking levels, frequency of intervention sessions, and population diversity (e.g. socioeconomic characteristics). Although the meta-analysis demonstrated intervention effectiveness in motherhood, both the number of

studies included and the pooled effect size were small, and the interventions varied in terms of population type and intervention approach. Therefore these findings should be interpreted with caution. Importantly, further attention is urgently needed to cover this time period neglected by research to prevent returning to previous or increased drinking levels while parenting (12) and the direct and indirect effects of non-dependent drinking (5). Research also needs to consider the complex interaction of psychosocial and physical-health factors that accompany problematic drinking behaviour and influence engagement in and efficacy of treatment. Finally, growing evidence shows that gender and the unique characteristics associated with a culture or group has an impact of treatment effectiveness (81). We argue that future research designed to reduce alcohol harm associated with maternal drinking should be tailored to the constraints, needs, and issues relevant to pregnant women and mothers.

The number of effective studies and lack of information in reports posed a barrier to identifying beneficial BCTs. In order to be able to understand and evaluate behaviour change interventions, there is a need for clearer reporting of the active components of interventions. Although it needs further improvement, the behaviour change technique taxonomy version 1 (BCTTv1; (16)) is a reliable tool to identify such intervention components and should be used by those reporting the content of their interventions (82). Future studies may choose to identify barriers and facilitators of stopping maternal drinking which could be mapped onto the Theoretical Domains Framework (83) to support identification of potentially effective maternal-specific BCTs. This is a strategy that has been found valuable in pregnancy smoking cessation (70) and may strengthen future interventions.

Reasons for and consequences of drinking, patterns of drinking, stigma, and likelihood of seeking help can differ across ethnicity (84). Therefore, interventions should take into account ethnic and cultural factors to enhance effectiveness (81, 85). Participant ethnicity differed in the current pregnancy RCTs, yet the majority of these failed to identify whether these factors were considered and none described how treatment was tailored. This is a further limitation in the current evidence base (86). Additionally, there was a high percentage of black and Hispanic women, therefore generalizability of the results to other ethnic groups may be unreliable.

Conclusion

Generally, research that evaluates the effectiveness of maternal alcohol reduction interventions involve primarily pregnant women and only few trials focus on motherhood. Brief interventions and motivational approaches show the most promise to change alcohol related

behaviour in pregnancy, but further investigation is warranted to establish their effectiveness both for pregnant and parenting mothers. Identification of maternal-specific BCTs requires better empirical evidence. Given the importance of helping non-dependent mothers drink within recommended guidelines, digital interventions might be a suitable and cost-effective approach which future research can establish. It is critical to recognise that the existing evidence base for what is an important public health issue is insufficient. There needs to be a fundamental change towards better quality and well-reported trials of interventions that are guided by appropriate behaviour change theories and employ effective BCTs. This could help overcome barriers and target facilitators of drinking within the relevant recommended guidelines during pregnancy, as well as in motherhood - a neglected time period in alcohol research.

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Data statement: Data is stored on OpenScienceFramework (https://osf.io/cteug/) (87)

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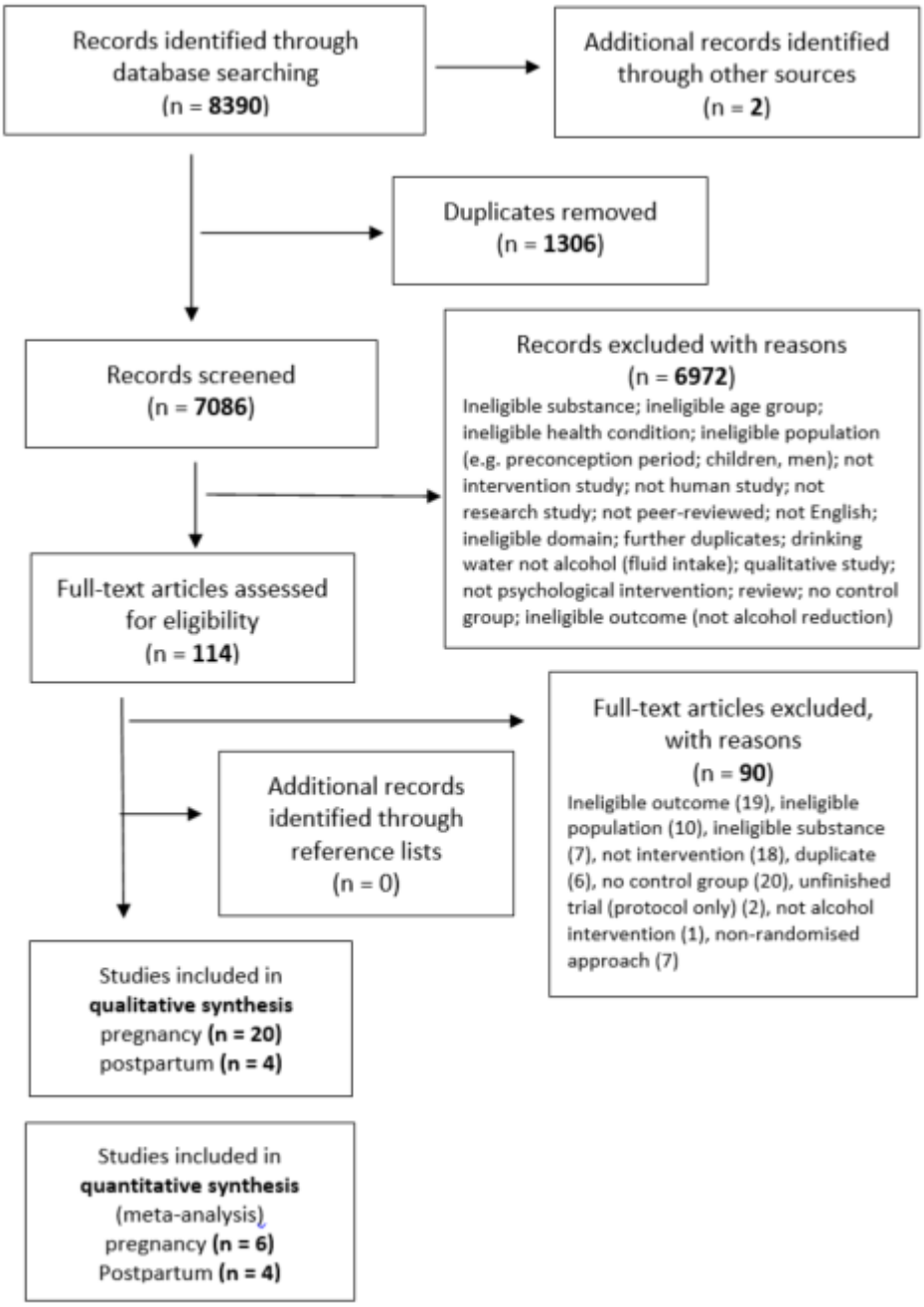

Figure 1. Search results and flowchart

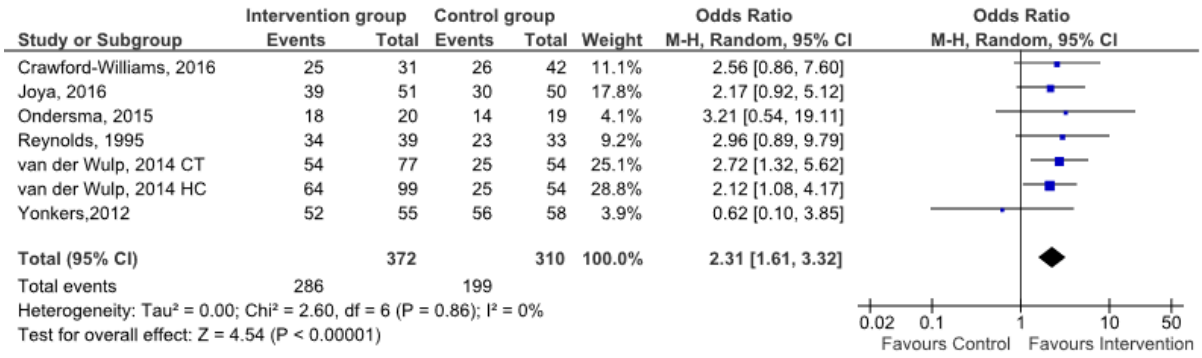

Figure 2. Forest plot showing an advantage for intervention group over control group in terms of abstinence in pregnancy. (CT = Computer-Tailored feedback; HC = Health Counselling).

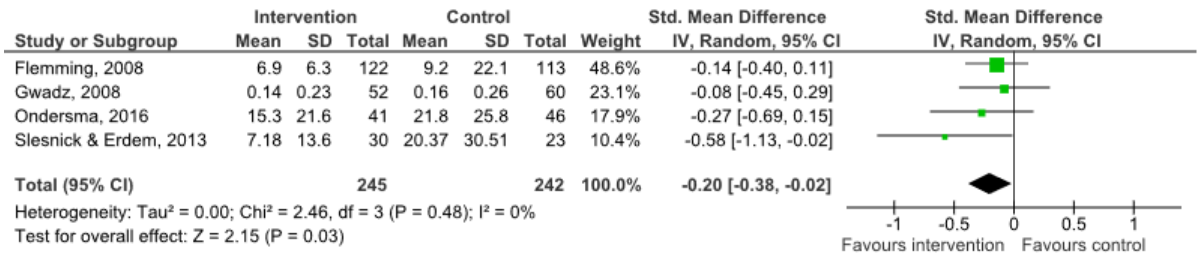

Figure 3. Forest plot showing an advantage for intervention group over control group in terms of alcohol reduction in motherhood when all studies included.

871 **Table 1. Search terms**

Population terms	Maternal OR mother OR perinatal OR postnatal OR postpartum OR "early motherhood" OR "parenting women" OR breastfeeding OR pregnan* OR prenatal
AND	
Behaviour terms	Alcohol OR drinking
AND	
Treatment terms	interven* OR preven* OR "behavio* change" OR "behavio* modification" OR program* OR "cognitive behavio* therapy" OR counselling OR "motivational interviewing" OR psychotherapy

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Table 2. Characteristics of pregnancy studies

Reference and country of origin	Participants Age, alcohol use, ethnic majority, week of gestation at baseline	Study design	Intervention type, delivery, and location	Comparison group	Outcomes and measures	Follow-up period	Results
1/ Belizan et al, 1995 [37] (additional information source: Villar et al, 1992; Langer et al, 1993) Argentina	N=2235 Mean age: IG: 24.3±6.6; CG: 24.6±6.6 Alcohol disorder: 31.4%; all heavy alcohol use 100% Hispanic Gestation (mean): 18.3 ±2.3	Individual RCT	4 home visits by social workers, obstetrics nurses 1-2 hours N=1115 or 1110	Routine prenatal care N=1120	Self-report Abstinence (daily alcohol drinking) No information on alcohol measure (interviews re health-related behaviours)	4 months (between 15-22 weeks and 36 weeks gestation)	Data analysed N=2028 (IG: 1009, CG: 1019) No significant decrease in drinking. No differences between groups. No statistics reported.
2/ Chang et al, 2005 [38] USA	N=304 Median age IG: 32 Mean age CG: 30.7 Less than 10% abstinent in the time period covered	Individual RCT	BI (single-session) By nurse or principle investigator Hospital N=152	No intervention N=152	Self-report Reduction - Frequency and quantity TLFB	Average # of weeks studied 22 (5 months)	Data analysed N=304 (IG=152, CG=152) No data on comparison of groups with all participants. Significant difference between groups: BI more effective in reducing frequency of

	Scored positive on T-ACE (risk drinking) 78.6% (239) white Gestation (median): 11(IG) 12(CG)						consumption among those who drank more at enrolment (b= –0.163, standard error [SE] (b) = 0.063, p<.01)
3/ Chang et al, 1999 [39] USA	N=250 Mean age: 30.7±5.4 (18-43) 43% drank while pregnant; 40% satisfied DSM criteria for life-time alcohol diagnoses. Scored positive on T-ACE (risk drinking) – pre-pregnancy and prenatal 78% (195) white Gestation (mean): 16±4.6	Individual RCT	BI Delivered by first author (Prof in psychiatry) Clinic and obstetric practices N=123	AO N=127	Self-report Reduction - Frequency and quantity Addiction Severity Index; TLFB; Alcohol Craving Scale; collateral report of antepartum drinking.	Average # of weeks studied 22 (5 months)	Data analysed N=247 IG and CG – no information Decline in antepartum drinking in both groups (IG: net decrease of 0.3 drink per drinking day; CG: net decrease of 0.4 drink per drinking day). No significant difference between groups (0.7 (IG) vs 1.0 (CG) drinking episode, p=.12). 143 participants abstinent while pregnant – less likely to drink if received BI

*4/ Crowford-Williams et al, 2016 [47] Australia	N=161 Mean age: 29.2 No alcohol disorder; no information on how many participants drank 80.7% (130) white Gestation: 2nd trimester	Individual RCT	Public Health Intervention: "Mocktails" – recipe booklet of non-alcoholic beverages Self-delivered Antenatal clinic N=82	Standard antenatal care N=79	Self-report Abstinence Standard questions from the National Drug Strategy Household Survey.	4-7.5 months (16-31 weeks)	Data analysed N=96 (IG=49, CG=47). Data analysed for abstinence outcome N=73 (IG=31, CG=42) No significant effect on changing alcohol consumption behaviour. Although a higher % of women in the IG abstained from alcohol throughout pregnancy (IG: 80.6%; CG: 61.9%), this result did not achieve significance (1.30 (0.97–1.75), p=0.077).
5/ Handmaker et al, 1999 [40] USA	N=42 Mean age 24 ± 5.76 years Light to heavy drinking 53% (22) Hispanic Gestation: not reported	Individual RCT (stratified by alcohol consumption)	MI (1 hour) – BI Conducted by first author Obstetric clinics N=20	Letter about potential risk of drinking and referral to health care provider N=22	Self-report Total alcohol consumption and abstinent days Follow-up Drink Profile	2 months within pregnancy (unclear at what gestational age women were recruited)	Data analysed N=34 IG=16, CG=18 No difference in total alcohol consumption (F = .01, 1/31 df, p = .94) and abstinent days (F = 1.25, 1/31 df, p = .27) between groups. For peak intoxication (BAC) level, women with high BAC levels

							showed significantly greater reduction with MI than control (F = 4.46, 1/30 df, p = .043)
*6/ Joya et al, 2016 [48] Spain	N=168 Mean age: IG: 32.3±5 CG: 29.9 ± 5.7 59% drank alcohol during pregnancy 42.3% (71) white Gestation: all gestation periods	Individual RCT	MI (single-session) (No mention of who delivered it) Hospital N=83	Single-session education group N=85	Self-report Abstinence Segmental hair analysis TLFB	4-6 months	Data analysed N=101 (CG=51, IG=50) No significant increase was found. Higher rate of abstinence in IG (75%) than CG (60%), but no differences between groups (p=.285)
7/ Marais et al, 2011 [53] South Africa	N=194 Mean age: 24 55% drank alcohol during pregnancy. 81.2% (160) black Gestation (mean): 14.8±4.1(IG) 14.8±4.6 (CG)	Pragmatic clustered RCT	BI By trained filed workers Clinics N=98	Assessment only N=96	Self-report Reduction - AUDIT	5 months (Less than 20 weeks pregnant and just before birth)	Data analysed N=179 (IG=97, CG=82) Decline in alcohol use in both interventions (IG: 72%; CG: 41%). Significant difference in alcohol reduction in AUDIT scores in favour of IG (IE = 1.97; SE = 0.64; p=.002)

8/ O'Connor & Whaley, 2007 [27] USA	N=345 Mean age IG:28.52±5.84 Mean age CG: 27.9±6.09 Any alcohol use TWEAK – high risk drinking 69.8% (178) Hispanic Gestation (mean): 17.78±7.76(IG) 18.15±7.99(CG)	Clustered RCT	BI By nutritionist Women, infants, and children centres N=162	Assessment only N=183	Self-report Reduction - Frequency and quantity, and abstinence Maximum drinks per drinking occasion	Screened at every monthly prenatal visit. 245 women were followed to 3rd trimester.	Data analysed N=255 (IG=117, CG=138) Significant reduction in both groups ($F_{1.241}$=4.33, p<.04) <u>Abstinence</u>: significant intervention effect - BI group 5 times more likely to be abstinent by 3rd trimester (OR=5.39; 95% CI=1.59, 18.25, p<.04) <u>Reduction</u>: women in the BI condition reported significantly lower drinking levels across both follow up periods ($F_{1, 183}$ = 7.02, p < .01)
*9/ Ondersma et al, 2015 [49] USA	N=48 Age: 18-37 25% alcohol disorder; all participants drank 81.3% (39) black	Pilot individual RCT	Computer-delivered Screening and BI Urban prenatal care clinic N=24	Intervention focused on infant nutrition (no mention of alcohol) N=24	Self-report Abstinence and frequency (number of drinking days) Alcohol subtest of the MINI International Neuropsychiatric Interview – 5.0	3 months (90 day period prevalence abstinence)	Data analysed N=39 (IG=20, CG=19) No significance increase in abstinence rate. Higher rate of abstinence and reduction in IG (90%) than CG (73.7%) but non-significant

	Gestation (mean): 12.5±5.6(IG) 12.0±5.3(CG)				At follow-up only - Timeline follow-back interview		difference between groups (p=.19) No data reported on reduction
10/ Osterman & Dyehouse, 2012 [43] USA	N=56 Mean age: 24.9 No alcohol disorder Low level of drinking 66.7% (37) black Gestation (mean): 20.71 (no sd reported)	Individual RCT	MI By researcher (certified psychiatric mental health clinical nurse specialist) Prenatal clinics N=29	No intervention CG=27	Self-report Reduction - Frequency (#of days drinking/week) and quantity (#of standard drinks/day) AUDIT	4-6 weeks	Data analysed N=56 (IG=29, CG=27) No significant differences between groups (p=.327)
11/ Osterman et al, 2014 [42] USA	N=122 Mean age: IG: 25.27±4.67 CG: 25.55±4.98 Low level of drinking 58.2% (71) black Gestation (mean): 23.60±8.72(IG) 23.14±8.72(CG)	Individual RCT	Single-session motivational intervention By researcher University Medical Centre N=62	No intervention N=60	Self-report Reduction - Frequency (drink days/week); quantity (drinks/day) AUDIT drink days per week, drinks per day QDS	30 days post-baseline 30 days postpartum	Data analysed N=118 (IG=60, CG=58) AUDIT – significant decrease in both groups (b = −1.86; z = −14.21, p b .01) QDS - No significant change in drinking behaviour No sign differences between groups

							No further relevant statistics reported.
12/ Osterman et al, 2017 [41] USA	N=41 Mean age: 27.6±6.2 About 25% used alcohol primarily. Ps were women entering treatment for substance use 40% (16) white Gestation (mean): 20.6±8.9(IG) 18.7±7.7(CG)	Individual Stratified RCT Secondary analysis of a clinical trial (Winhusen et al, 2008 – not in our search	MET By clinicians trained by MET experts Substance abuse treatment service N=27	TAU CG=14	Self-report Reduction – frequency (days of alcohol use in the past 28 days) TLFB	Active study phase: weekly measuring for up to 4 weeks Follow up: 2 and 4 months	Data analysed N=41 (IG=27, CG=14) <u>Active study phase</u>: decrease in both groups; non-significant treatment (X2 = 1.49, df = 1, p N 0.05), time (X2 = 2.63, df = 1, p N 0.05), and time and treatment X time interaction effects (X2 = 2.64, df = 1, p N 0.05). <u>12-week follow up</u>: Significant time (X2=16.76, df=1, p b 0.0001) and treatment × time interaction (X2 = 13.07, df = 1, p b 0.001) effects with MET lower levels of alcohol use relative to TAU. No significant treatment effect on alcohol use days.
13/ Reading et al, 1982 [44] UK	N=129 Mean age IG: 24.7±4 CG: 25.1±4	Individual RCT	High feedback – ultrasound and specific visual, verbal feedback By clinician	Low feedback – examination and interview (no	Self-report Reduction Measures not specified (questionnaire re	Before and after ultrasound	Data analysed N=129 (IG=67, CG=62) No significant difference with respect to ultrasound

	69% not drinking Moderate to heavy drinking: N=8 (6.2%) 100% white Gestation: not reported (first ultrasound)		Antenatal booking clinic N=67	monitor or feedback) N=62	health beliefs and behaviour) Participants were asked if they decreased their alcohol consumption since the scan at 16-week appointment		conditions and decrease in alcohol consumption (χ^2=5.5, df=2, p=.064.
*14/ Reynolds et al, 1995 [50] USA	N=78 Mean age: 22.4 All participants drank 66.7% (52) black Gestation: all gestation periods	Individual RCT	Cognitive behavioural self-help intervention Instruction provided by an educator on how to perform the intervention Clinic N=42	Usual care N=36	Self-report Abstinence and reduction (frequency and quantity) 47-item questionnaire including alcohol consumption, (past month, how many days, how much, binge drinking) Quantity and frequency of alcohol consumption	3 months	Data analysed N=72 (IG=39, CG=33) An overall quit rate favouring the intervention group was observed (88%) compared to the CG (69%) but differences between groups only approached significance between groups ($\chi^2(1) = 3.6$, p<.058). No significant differences between groups for reduction (t(1, 63) = 1.9, p<.06.
15/ Rotheram-Borus et al, 2019 [54]	N=1238 Mean age: 26.4 IG: 26.5 CG: 26.3	Clustered RCT	Home visits (4 antenatal – one alcohol-related session, 4 postnatal) –	Standard care N=594	Self-report Reduction and abstinence	2 weeks to 60 months	Data analysed 2 weeks – no information 6 month N=1060

			BI, cognitive-behaviour change strategies By trained mentor mothers N=644		AUDIT		(IG=487, CG=573) 18 month N=1039 (IG=487, CG=543) 36 month N=952 (IG=497, CG=455) 60 month N=920 (IG=477, CG=443) In general, alcohol use increased in both groups postpartum. At 5-year follow-up – IG participants are less likely to be problem drinkers but no statistical significance between groups (–.04 [–.35, .28], p=.82) No statistics reported for pregnancy period.
16/ Rubio et al, 2014 [52] USA	N=330 Mean age IG: 23.5±4.04 Mean age CG: 24.1±5.40 Substantial alcohol use before pregnancy. Fewer than 35% reported any alcohol use between	Individual RCT	Brief motivational enhancement By registered nurse or lay counsellor trained by investigators Urban obstetric clinic Intervention during pregnancy and postpartum N=165	Usual care N=165	Self-report Reduction (quantity) and abstinence A validated instrument developed by Maternal Health Practices and Child Development Project	(Max 20 weeks of gestation) 6 weeks; 6 months, 12 months postpartum	Data analysed N=251 (IG=125, CG=126) No pregnancy data. <u>Postpartum:</u> Any alcohol use: non-significant intervention effect Drinks per day: both groups increased drinks/day at each time point but neither group

	recognition of pregnancy and enrolment 53.6% (177) black Gestation (mean): 9.9±4.3(IG) 9.7±3.8(CG)						returned to pre-pregnancy drinking. No significant differences between groups
17/ Tzilos et al, 2011 [45] USA	N=50 Mean age: IG: 25±4.93 CG: 26.4±5.52 74% reported quitting alcohol use before participation – no information on level of drinking for the remaining 26% (Overall, 72% reported any drinking at baseline, and 10% reported any drinking at follow up) 82% (41) black	Individual RCT	Single-session computer-delivered BI Prenatal care clinic N=27	No intervention N=23	Self-report Reduction (quantity) and abstinence (No/Any drinking), TLFB computer-modified version over past month	1 month	Data analysed N=50 (IG=27, CG=23) <u>Reduction</u>: Both groups reduced alcohol use (W= 25, $p < 0.01$, r= -0.73) <u>Abstinence</u>: overall, 72% reported any drinking at baseline and 10% at follow-up. No difference between conditions (p=.71).

	Gestation (mean): 25±8.45(IG) 25.5±7.63(CG)						
*18/ van der Wulp, 2014 [32] Netherlands	N=393 Mean age: 32.56±4.2 No alcohol disorder; all participants drank Ethnicity not reported Gestation (mean): 7.87±1.96	Clustered RCT	HC by midwives, N=135 OR Internet-based CT, N=116 Midwife practices	Usual care N=142	Self-report Abstinence and reduction (quantity – drinks/week) Self-report Post-test drinking behaviour – "Have you had at least one sip of alcohol since the previous questionnaire	3 months (T1) 6 months (T2)	Data analysed N=176 (IG=99, CG=77) <u>Abstinence (H1)</u>: <u>Time 1</u> - HC: 65%, CT: 70%, CG: 45.4% - non-significant differences (HC vs CG: p=.79; CT vs CG: p=.15) <u>Time 2</u>: HC: 72%, CT: 78%, CG: 55% - non-significant differences for HC vs CG (p=.26), and significant differences for CT vs CG: p=.04) <u>Reduction (H2)</u>: <u>Time 1</u>- HC: 0.56(0.91), CT: 0.25(0.27), CG: 0.51(0.54) – non-significant differences for HC vs CG (p=.58), CT vs CG (p=.23). <u>Time 2</u> – HC: 0.77(1.36), CT: 0.35(0.31), CG: 0.48(0.54) – non-significant differences

							for HC vs CG (p=.23). Significant differences in favour of CT vs CG for respondents with average (p=.007) or 1 SD below average alcohol use pre-pregnancy. Results were non-significant for respondents with 1 SD above average (p=.57).
19/ Waterson & Murray-Lyon, 1990 [46] UK	Trial 1 N=1036 IG=559 (37% drinking) CG=477 (39% dinking) Trial 2 N=1064 IG=500 (34%) CG=564 (34%) No information on age 1 unit of alcohol or more per day Ethnicity not reported Gestation: not reported (first	Individual RCT	Trial I. – Written information + personal advice and reinforcement by doctor Trial II. – Written information + personal advice + specially produced video By doctor Antenatal clinic	Same written info alone Same written information alone	Self-report Reduction - frequency and quantity of alcohol use, frequency of binge drinking CAGE questions	Questionnaire 1 (Q1): 7 months after intake (at first visit to clinic); Questionnaire 2 (Q2): just after delivery	Data analysed Trial 1 Q1 N=611 Trial 1 Q2 N=767 Trial 2 Q1 N=532 Trial 2 Q2 N=362 No significant differences within or between trials No significant differences between groups. No statistics reported.

	antenatal care visit)						
*20/ Yonkers et al, 2012 [51] USA	N=183 Age: <20: 29 20-34: 126 35+: 13 Any alcohol use, intoxication: N=68 Primary alcohol use N=51 53% (89) black Gestation: under 28 weeks at screening	Individual RCT	MET coupled with CBT By trained research nurse therapists Hospital-based reproductive health clinic N=92	Brief advice N=91	Self-report Abstinence TLFB	3 months	Data analysed N=168 (IG=82, CG=86) Data analysed for abstinence outcome N=113 (IG=55, CG=58) Substance use decreased in both groups between intake and delivery but increased again after delivery. Treatment effects did not differ between groups (IG: 95%; CG: 97%), no p value available.

*included in meta-analysis; N=total number of participants; IG = Intervention Group; CG = Control Group, RCT = Randomized Controlled Trial, BI = Brief Intervention, TLFB = Timeline Follow Back, AO = Assessment Only, MI = Motivational Interviewing, BAC = Blood Alcohol Concentration, AUDIT = Alcohol Use Disorder Identification Test, QDS = Quick Drinking Screen, MET = Motivational Enhancement Therapy, TAU = Treatment AS Usual, HC = Health Counselling, CT – Computer-Tailored feedback, CBT = Cognitive Behaviour Therapy.

Table 3. Characteristics of motherhood studies

Reference and country of origin	Participants Age, alcohol use, ethnic majority, age of children	Study design	Intervention type, delivery, and location	Comparison group	Outcomes and measures	Follow-up period	Results
1/ Fleming et al, 2008 [55] USA	N=235 Median age: 28 (18-41+) High risk drinking 81.7% (192) white Age of children: 45 days postpartum	Individual RCT	Brief intervention By trained researchers Obstetric clinics N=122	Usual care N=113	Self-report Reduction - Quantity (mean # of standard drinks); frequency (mean # of drinking days); mean # of heavy drinking days (four or more drinks) in the previous 28 days TLFB	6 months	Data analysed N=235 (IG=122, CG=113) Significant reduction in the mean # of drinks; # of drinking days; and heavy drinking days in past 28 days Significant differences between groups in favour of the BI group
2/ Gwadz et al, 2008 [56] USA	N=118 Mean age: 40.9±6.1 Problem drinking 56.8% (67) black Age of children: 11-18 years	Individual RCT	Social-cognitive behavioural intervention 14 sessions "Family First" Trained and experienced master's-level clinicians Community-based organisations and hospital clinics N=57	Single-session social/motivational intervention (Brief video intervention) N=61	Self-report Reduction (frequency and quantity) Computer-assisted personal interviewing; Audio-computer assisted self-interviewing	3, 6, 12, 18 months	Data analysed 3 month N=109 (IG=51, CG=58) 6 month N=112 (IG=52, CG=60) 12 month N=106 (IG=51, CG=55) 18 month N=111 (IG=52, CG=59) A general trend of reduction in both interventions

							Those with greater initial substance use maintained reduction over a longer period of time in SCBI
3/ Ondersma et al, 2016 [57] USA	N=123 Mean age: 27.1±6 High risk drinking 87% (107) black Age of children: during impatient hospitalisation for childbirth.	Individual RCT	Computer-Delivered Screening and BI Hospital N=61	No intervention (time-control group) N=62	Self-report Reduction – frequency (drinking days); quantity (mean drinks/week); binge episodes/week TLFB Computer-modified version over past week and past 90 days National Institute on Alcohol Abuse and Alcoholism – quantity/frequency and binge drinking	3 and 6 months	Data analysed 3 month N=83 (IG=41, CG=42) 6 month N=87 (IG=41, CG=46) No significant reduction No between-group differences were significant 7-day point prevalence abstinence
4/ Slesnick & Erdem, 2013 [28] USA	N=60 Mean age: 26.3±6.1 Substance use disorder 75% (45) black Age of children:	Individual pilot RCT	EBT (rental/utility assistance, case management, substance abuse counselling) By master's-level therapists Homeless family shelter N=30	TAU (housing and services) N=30	Self-report Frequency and quantity of drug/alcohol use The Form 90 Interview	3, 6, 9 months	Data analysed 3 month N=54 (IG=30, CG=24) 6 month N=53 (IG=30, CG=23) 9 month N=55 (IG=30, CG=25) EBT – quicker decline in alcohol use and frequency than TAU

								2-6 years Mean age: 3.68±1.41	

All motherhood studies were included in meta-analysis. N = total number of participants; IG = Intervention Group; CG = Control Group; SUD = Substance Use Disorder; RCT = Randomized Controlled Trial, TLFB = Timeline Follow Back, TAU = Treatment AS Usual, EBT = Ecologically-Based Treatment.

Table 4. Assessment of risk of bias by domains and overall

Study	**Domain 1** Randomization	**Domain 2** Deviations from the intended interventions (effect of assignment)	**Domain 3** Missing outcome data	**Domain 4** Outcome measurement	**Domain 5** Selection of reported results	**Overall risk of bias judgement**
Pregnancy						
Belizan et al, 1994 [37]	Low	Low	Low	High	Some concerns	**High**
Chang et al, 2005 [38]	Low	Low	Low	High	Some concerns	**High**
Chang et al, 1999 [39]	Some concerns	High	Low	High	Some concerns	**High**
*Crowford-Williams et al, 2016 [47]	Low	Some concerns	Low	High	Some concerns	**High**
Handmaker et al, 1999 [40]	Low	Some concerns	High	High	Some concerns	**High**
*Joya et al, 2016 [48]	Some concerns	Some concerns	Low	Low	Some concerns	**Some concerns**
Marais et al, 2011 [53]	Some concerns/Low	Some concerns	Low	High	Low	**High**
O'Connor &Whaley, 2007 [27]	Some concerns	Some concerns	Low	High	Low	**High**
*Ondersma et al, 2015 [49]	Some concerns	Some concerns	Low	High	Some concerns	**High**
Osterman & Dyehouse, 2012 [43]	Some concerns	Some concerns	High	High	Some concerns	**High**
Osterman et al, 2014 [42]	Low	Low	Low	High	Some concerns	**High**
Osterman et al, 2017 [41]	Some concerns	High	High	High	Some concerns	**High**

Reading et al, 1982 [44]	Some concerns	High	High	High	Some concerns	**High**
*Reynolds et al, 1995 [50]	Low	High	Low	High	Some concerns	**High**
Rotheram-Borus et al, 2019 [54]	Low	Low	Some concerns	High	Low	**High**
Rubio et al, 2014 [52]	Low	Low	Low	High	Some concerns	**High**
Tzilos et al, 2011 [45]	Low	Low	Low	High	Some concerns	**High**
*van der Wulp, 2014 [32] (cluster)	Some concerns/High	High	High	High	Low	**High**
Waterson & Murray-Lyon, 1990 [46]	Some concerns	Some concerns	Low	High	Some concerns	**High**
*Yonkers et al, 2012 [51]	Low	High	Low	High	Some concerns	**High**
Motherhood						
*Fleming et al, 2008 [55]	Low	Low	Low	High	Some concerns	**High**
*Gwadz et al, 2008 [56]	Some concerns	Low	Low	High	Some concerns	**High**
*Ondersma et al, 2016 [57]	Low	Low	Low	Some concerns	Some concerns	**Some concerns**
*Slesnick & Erdem, 2013 [28]	Some concerns	High	Low	High	Some concerns	**High**

*Studies included in meta-analysis

Table 5. BCTs in effective/partially effective studies

Reference	Results	General BCTs	Alcohol-specific BCTs
Effective pregnancy interventions			
Marais et al, 2011 [53]	Significant difference in alcohol reduction in AUDIT scores in favour of IG.	2.2 Feedback on behaviour	5.Provide feedback on performance 14.Facilitate goal setting
O'Connor and Whaley, 2007 [27]	Significant intervention effect - BI group 5 times more likely to be abstinent by 3rd trimester	1.1 Goal setting (behaviour) 1.2 Problem solving 1.3 Goal setting (outcome) 1.4 Action planning 1.8 Behavioural contract 3.1 Social support (unspecified) 5.1 Information about health consequences 5.2 Salience of consequences 6.2 Social comparison 8.2 Behaviour substitution 8.4 Habit reversal 8.7 Graded tasks 15.1 Verbal persuasion about capability 15.4 Self-talk	1.Provide information on consequences of excessive alcohol consumption and reducing excessive alcohol consumption 3.Boost motivation and self-efficacy 4.Provide normative information about others' behaviour and experiences 14.Facilitating goal setting 15.Facilitate action planning/help identify relapse triggers 17.Behavioural substitution 21.Facilitate barrier identification and problem solving 23. Set graded tasks 26.Advice on/facilitate use of social support 29.Assess current readiness and ability to reduce excessive alcohol consumption *39.Summarise information/confirm client decisions*
Partially effective pregnancy interventions			
Chang et al, 2005 [38]	BI was more effective in reducing frequency of consumption among heavier drinkers at enrolment. BI was also more effective for heavier drinkers when their partner was involved (social support). No information available on differences in overall reduction between groups.	1.1 Goal setting (behaviour) 1.2 Problem solving 1.8 Behavioural contract 3.2 Social support (practical) 3.3 Social support (emotional) 8.2 Behaviour substitution	14.Facilitate goal setting 17.Behaviour substitution 21.Facilitate barrier identification and problem solving 26. Advise on/facilitate use of social support 40. Elicit and answer questions

Handmaker et al, 1999 [40]	No difference in total alcohol consumption and abstinent days between groups. For peak intoxication (BAC) level, women with high BAC levels showed significantly greater reduction with MI than control.	2.2 Feedback on behaviour 3.1 Social support (unspecified) 5.1 Information about health consequences	1.Provide information on consequences of excessive alcohol consumption and reducing excessive alcohol consumption 5.Provide feedback on performance 13.Explain the importance of abrupt cessation 26.Advice on/facilitate use of social support 29.Assess current readiness and ability to reduce excessive alcohol consumption 35.Tailor interactions appropriately
Osterman et al, 2017 [41]	Active study phase: non-significant treatment, time and treatment X time interaction effects. 12-month follow up: Significant time and treatment X time interaction effects with MET lower levels of alcohol use relative to TAU (IG sustained lower levels of drinking and CG returned to increased levels) No significant treatment effect on alcohol use days.	1.1 Goal setting (behaviour) 1.6 Discrepancy between current behaviour and goal 2.2 Feedback on behaviour 3.1 Social support (unspecified) 4.2 Information about antecedents 5.1 Information about health consequences 15.1 Verbal persuasion about capability	1.Provide information on consequences of excessive alcohol consumption and reducing excessive alcohol consumption 3.Boost motivation and self-efficacy 5.Provide feedback on performance 9.Conduct motivational interviewing 14.Facilitate goal setting 26.Advice on/facilitate use of social support 31.Assess current and past drinking behaviour 35.Tailor interactions appropriately 36.Build general rapport 37.Use reflective listening *39.Summarise information/confirm client decisions*
Van der Wulp et al, 2014 [32]	Internet-Based Computer-Tailored Feedback: Abstinence (H1): Intervention group stopped using alcohol more often than usual care at Time 2. Reduction (H2): Significant differences only at Time 2 in favour of intervention. (Non-significant results regarding the health counselling intervention.)	1.2 Problem solving 1.4 Action planning 3.1 Social support (unspecified) 5.1 Information about health consequences 8.2 Behaviour substitution 9.1 Credible source 12.1 Restructuring the physical environment	1. Provide information on consequences of excessive alcohol consumption and reducing excessive alcohol consumption 15.Facilitate action planning/help identify relapse triggers 17.Behaviour substitution 19.Facilitate relapse prevention and coping 22.Advice on environmental restructuring 26. Advise on/facilitate use of social support

		12.2 Restructuring the social environment	
Effective motherhood interventions			
Fleming et al, 2008 [55]	Significant differences between groups in favour of the brief intervention group	1.1 Goal setting (behaviour) 1.5 Review behaviour goal(s) 1.8 Behavioural contract 1.9 Commitment 2.2 Feedback on behaviour 2.3 Self-monitoring behaviour 3.1 Social support (unspecified) 5.1 Information about health consequences 6.2 Social comparison 9.1 Credible source 12.3 Avoidance/reducing exposure to cues for the behaviour	1.Provide information on consequences of excessive alcohol consumption and reducing excessive alcohol consumption 4.Provide normative information about others' behaviour and experiences 8.Prompt commitment from the client there and then 14.Facilitate goal setting 16.Advice on avoidance of social cues for drinking 20.Prompt self-recording
Slesnick & Erdem, 2013 [28]	Quicker decline in alcohol use and frequency in ecologically-based intervention group compared to treatment as usual	1.1 goal setting (behaviour) 1.2 Problem solving 3.1 Social support (unspecified) 4.1 Instructions on how to perform a behaviour 5.1 Information about health consequences 8.1 Behavioural practice/rehearsal 8.2 Behaviour substitution 8.4 Habit reversal 11.2 Reduce negative emotions	1.Provide information on consequences of excessive alcohol consumption and reducing excessive alcohol consumption 14.Facilitate goal setting 15.Facilitate action planning/help identify relapse triggers 17.Behaviour substitution 19.Facilitate relapse prevention and coping 21.Facilitate barrier identification and problem solving 26.Advice on/facilitate use of social support 27.Give options for additional and later support 42.General communications skills training

15.4 Self-talk

IG = Intervention Group, CG = Control Group, BI = Brief Intervention, BAC = Blood Alcohol Concentration, MET = Motivational Enhancement Therapy, TAU = Treatment As Usual, H = Hypothesis.