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REVIEW

ADDICTION SSA

Smoking cessation interventions for pregnant women attending treatment for substance use disorders: A systematic review

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Abstract

Background and aims: Up to 95% of pregnant women seeking treatment for alcohol and other drug (AOD) use smoke tobacco. Previous reviews indicate few effective smoking cessation treatments for this group. This updated review aimed to identify and measure the efficacy of smoking cessation interventions trialled among pregnant women in AOD treatment settings who smoke tobacco.

Methods: A narrative synthesis was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement. Studies involving psychological, behavioural or pharmacological interventions used to treat tobacco use, including electronic nicotine delivery systems, for pregnant women of any age, who smoked tobacco and were seeking/receiving treatment, or in post-treatment recovery for AOD concerns, were reviewed. MEDLINE, PsycINFO, CINAHL, EMBASE and ProQuest databases, grey literature and reference lists were searched, and field experts were contacted for unpublished study data. The Effective Public Health Practice Project tool assessed study quality. The review was pre-registered with PROSPERO no. CRD42018108777.

Results: Seven interventions (two randomised controlled trials, two single-arm pilot studies, two program evaluations and one causal comparative study) treating 875 women were identified. All were United States (US)-based and targeted women with drug dependence, but not alcohol dependence. Three interventions used contingency management, five provided behavioural counselling, and one offered nicotine replacement therapy. All reported reductions in cigarette consumption; one contingency management-based study demonstrated higher abstinence rates compared with controls at treatment-end that were not maintained at follow-up. Four of six studies were rated as methodologically weak and one unpublished study was not rated.

Conclusions: Conclusions about the efficacy of smoking interventions for pregnant women with alcohol and other drug concerns who also smoke tobacco are hindered by the paucity of available data and poor methodological quality of included studies.

KEYWORDS
alcohol and other drugs, interventions, pregnancy, smoking, smoking cessation, substance use disorder, systematic review, tobacco, treatment

INTRODUCTION

Across countries and cultures, the highest rates of tobacco smoking are seen in groups who experience the lowest levels of socioeconomic advantage [1]. In Australia, the most disadvantaged pregnant women are six times more likely to smoke during the first half of their pregnancy than the least disadvantaged women (18% compared to 3%) [2]. These women are also more likely to experience problematic alcohol and other drug (AOD) use [3] with up to 95% of those seeking treatment for substance use in pregnancy reporting tobacco smoking [4,5]. These figures are in stark contrast to those of general population pregnant women who smoke, currently at 10% in Australia [6].

Smoking rates in populations with maternal substance use are influenced and perpetuated by many of the psychosocial challenges that characterise this group, including stigma [7], mental illness [8], trauma [9], intimate partner violence and child protection issues [10]. Although smoking cessation often receives little attention [11], many women express a desire to quit, motivated by the health of their baby [12,13]. Smoking cessation treatments with an evidence-base in pregnancy, including nicotine replacement therapy (NRT) [14], contingency management (CM), and behavioural counselling are available [15], but evidence for their effectiveness in this population is lacking.

The dearth of research in this area was highlighted by two reviews. The first from 2014 was restricted to pregnant women receiving opioid agonist treatment (OAT) [5]. Three behavioural interventions were identified [16–18], with one having a significant impact on smoking abstinence [16]. A second from 2011 examined all pregnancy specific, experimentally designed cessation interventions from 1990 to 2010 [19]. Of the 97 found, two targeted AOD populations [17,20]. One study [17] appeared in the aforementioned review, but neither resulted in significant abstinence for participants. The restricted search criteria may have overlooked some trialled interventions, and an up-to-date review with wider scope is required.

Review aim and scope

This review will identify and examine interventions that quantitatively assess smoking cessation outcomes trialled in pregnant women receiving AOD treatment who smoke tobacco, regardless of their substance of concern, study methodology or time since studied. Findings will be used to inform future interventions to address the extensive presence of smoking in this high-priority group.

METHODS

This review is reported according to recommendations outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [21]. The review was registered with PROSPERO (no. CRD42018108777) before protocol publication [22].

Search strategies

Given the limited number of studies, small sample sizes and negative findings found in earlier reviews, a search strategy that considered publication bias was devised. MEDLINE, PsycINFO, CINAHL, EMBASE and ProQuest Dissertations and Theses Global were searched using a combination of terms associated with tobacco use, pregnancy, psychoactive substance use and smoking cessation interventions (see Supporting Information). Database searches were conducted in February 2019, January 2020 and updated in May 2021. Three iterations of a Google Scholar search, limiting results to 20 pages, and a review of reference lists were also performed. Last, field experts were contacted about studies that matched the criteria, but had not been published or identified in the search strategy.

Inclusion criteria

Studies of any design methodology that quantitatively reported changes in tobacco smoking behaviours were included. ‘Tobacco’ for this review, encompassed all combustible products including cigarettes, cigars, pipes and hookahs.

Participants were pregnant women of any age who smoked tobacco and were seeking or receiving treatment, or in post-treatment recovery, for AOD concerns. Interventions included any psychological, behavioural or pharmacological treatments used to treat tobacco use, including electronic nicotine delivery systems. Treatments specifically targeting cannabis smoking were excluded.

Data extraction

Abstract screening against eligibility criteria, full text reviews and data extraction was completed independently by M.A.J. and K.M. Reasons for article exclusion were documented and any discrepancies resolved by discussion.

Quality of evidence

A qualitative assessment of included published studies was undertaken using the Effective Public Health Practice Project (EPHPP) quality assessment tool for quantitative studies [23]. This tool evaluates selection bias, study design, confounders, blinding, data collection methods and withdrawals/dropouts as ‘strong’, ‘moderate’ or ‘weak’. An overall global rating of strong (no weak ratings), moderate (one

weak rating) or weak (two or more weak ratings) is made. The 'blinding' criteria were considered inappropriate for the studies under review. Its inclusion skewed results unnecessarily yielding a weak rating for all but one study.

Data synthesis

The small number of studies and heterogeneity of research designs, interventions and smoking-related outcome measures, precluded meta-analysis. A narrative synthesis of outcomes was instead conducted.

RESULTS

The initial search returned over 2000 articles, of which six were included in the final review [16–18,20,24,25] including four previously identified [16–18,20]. The unpublished results of an additional study came from an expert contact [26]. Figure 1 illustrates the screening process. Table 1 details the reviewed studies.

Study characteristics

All studies were conducted in the United States (US) between 1996 and 2019, incorporating 875 women. They comprised a variety of methodological designs: two randomized controlled trials (RCTs) [16,17]; two single-arm pilot studies [24,26]; two program evaluations [20,25] and one causal comparative study [18].

Participants

Five studies targeted women receiving OAT [16–18,24,26] and two targeted those in treatment for general drug dependence [20,25].. No studies among women receiving alcohol treatment were found.

Interventions

All interventions incorporated two or three evidence-based smoking cessation strategies including an educational component (verbal or printed materials). Three treatments used CM, a strategy that incentivises smoking abstinence or reduction to positively reinforce desired behaviour changes. Financial incentives [16,26] or prize-based incentives [20] were delivered, contingent on carbon monoxide (CO) samples being below a predetermined target.

Six treatments provided behavioural counselling, delivered either individually [17,25,26] or in group format [18,20,24]. Two studies also added individualised support via external referrals and assistance to address barriers to cessation [24] or positive verbal reinforcement from staff during clinic encounters [25]. Only one treatment offered participants access to NRT [20].

Outcome measures

Smoking related

Four studies provided self-reported cigarettes per day (CPD) data at baseline and follow-up [16,18,24,26]. Others provided proportional CPD data [25], significance statistics without group means [17] and numbers of tobacco use days in the past 30 [20].

Five studies sought biochemical verification of smoking status using breath CO [16,17,20,24,26] with cut-offs varying from ≤3 to <10 p.p.m. Urine cotinine (200 ng/mL cut-off) provided additional verification in two studies [16,17]. Other tobacco use outcomes included nicotine dependence [24]; nicotine withdrawal symptoms [20]; motivation and confidence to quit [24]; stages-of-change continuum [17,20]; and second hand smoke exposure [24]. One study examined predictors of smoking outcomes [18].

Other outcomes

Three studies assessed treatment acceptability [20,24,25]. One evaluated improvements in maternal depression, anxiety and recovery capital [24] and one CM study provided group comparisons of pregnancy and neonatal outcomes impacted by smoking. Incentive earnings were also reported [16]. No studies assessed changes in other substance use as an outcome.

Quality

Overall, one study was rated strong, one moderate and four weak. No assessment was made for the unpublished study [26].

Intervention outcomes

Interventions not previously reviewed

Fallin-Bennett et al. evaluated a group-counselling program in pregnant and postpartum women receiving OAT (n = 50) [24]. The program produced significant reductions in past 30-day CPD. CO also decreased, but not significantly. Decreased nicotine dependence and improved depression, anxiety and stress symptomatology was reported. Confidence and motivation to quit increased, although not significantly. Decreased cigarette consumption led to increased recovery capital being available to sustain abstinence from substance use, again not significantly. A total of 124 referrals to assist

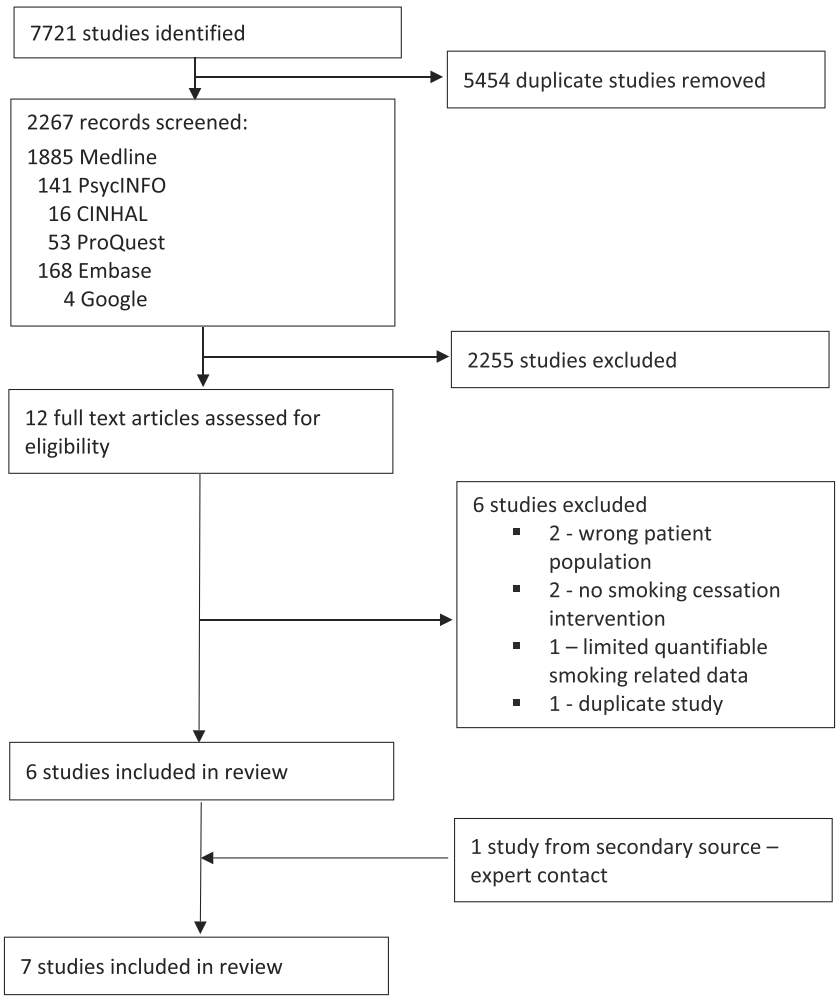

FIGURE 1 Search process and study selection

in reducing barriers to cessation were given to 38 women, mostly for external smoking cessation classes, counselling, contraception or obstetric care.

An unpublished pilot study by Kurti assessed whether incentivizing gradual reductions in smoking rather than complete abstinence would be more effective in pregnant, opioid dependent women (n = 15) [26]. Financial incentives were offered for achieving CO-verified reduction targets (identical to Tuten et al. [16]) over 12-weeks, before incentives were contingent on cotinine-verified abstinence. Some participants achieved CO-verified abstinence at treatment-end, but were not supported by cotinine verification, so no follow-ups were made. Reductions in CPD were reported.

Waller et al. evaluated an education and counselling-based smoking cessation program for women with AOD concerns enrolled in a substance use prevention program (n = 514) [25]. Approximately half either abstained or reduced smoking. However, no statistics or verification of self-report were provided. Women reported increased awareness of smoking related harm and overall program satisfaction.

Previously reviewed interventions

An RCT by Tuten et al. examined the effectiveness of a 12-week intervention using contingent incentives to reduce tobacco smoking in women receiving OAT (n = 102) [16]. Their treatment group had significantly higher rates of CO verified smoking abstinence and reduction at end-of-treatment, but this was not maintained at follow-up. This was the only study that provided evidence for tobacco smoking abstinence and provided comparisons of maternal and neonatal outcomes, finding clinically relevant differences between treatment and comparison groups.

Haug et al. reported on a 6-week RCT of counselling-based smoking intervention versus standard care to promote abstinence in pregnant women receiving OAT (n = 63) [17]. CPD decreased significantly from baseline to follow-up, however, CO and cotinine increased significantly over the same period. The treatment group were significantly more likely to have progressed on the stages-of-change continuum at follow-up than those from standard care.

Holbrook et al. compared a 6-week group counselling intervention between pregnant and parenting women receiving OAT (n = 91)

TABLE 1 Description of included studies and smoking cessation interventions.

Author (year) country	*Study Type*	*Recruitment setting and participant characteristics*	*Baseline tobacco smoking*	*Treatment groups (n)*	*Intervention strategies*
Tuten M. et al. (2012) [16] USA Previously reviewed [5]	RCT[b]	Setting: Centre for Addiction and Pregnancy inpatient + outpatient program Participants: pregnant women receiving OAT[c]	CPD[d] M (SD) = 18 (8.6)	1. Contingent behavioural incentives (CBI[e]; *n* = 42) 2. Non-contingent behavioural incentives (NCBI[f]; *n* = 28) 3. Treatment as usual (TAU[g]; *n* = 32)	CBI: Financial incentives contingent on CO verified abstinence + TAU vs NCBI: Financial incentives yoked to a previously generated CO[h] schedule (not linked to participants own smoking) + TAU Vs. TAU: Printed educational materials
Holbrook A. et al. (2011) [18] USA Previously reviewed [5]	Causal comparative study	Setting: Outpatient substance use treatment facility Participants: Opioid dependent pregnant (*n* = 44) or parenting (*n* = 47) women	CPD M (SD) = 18.8 (10.1)	1.Group 5As[j] treatment program (*n* = 91)	Group counselling Intervention based on 5As model of cessation. Group content includes assessment of nicotine use, education on smoking risks and cessation benefits, identification of quit motivations and smoking triggers, and coping skills. (8–15 people/group)
Haug N. et al. (2004) [17] USA Previously reviewed [5,19]	RCT	Setting: Hospital-based 7-day residential treatment facility Participants: Pregnant women receiving OAT	CPD M (SD) = 19.9 (11.5)	1. MET[k] (*n* = 30) 2. SC[l] (*n* = 33)	MET (4 sessions) + SC Vs. SC consisting of advice on reducing tobacco
Ker M. et al. (1996) [20] USA Previously reviewed [19]	Non-equivalent group design/program evaluation	Setting: Long-term residential rehabilitation facilities Participants: Pregnant and postpartum women with substance use disorder 64% crack or other cocaine; 21% crystal methamphetamine; 14% heroin or other opioids	Treatment group – 80% of total admissions self- reported tobacco use Comparison group – 90% of total admissions self- reported tobacco use	1. Treatment: residential setting – smoke free with involuntary smoking cessation program (*n* = 26) 2. Comparison: residential setting – smoking permitted (*n* = 14)	1. Prize-based incentives contingent on CO verified abstinence 2. Long-acting NRT 3. Group education on risks of smoking
Fallin-Bennett A. et al. (2019) [24] USA	Single-arm pilot study	Setting: University Department of Obstetrics and Gynaecology Participants: Pregnant and post-partum women, most with opioid use disorder (*n* = 42 or 84%)	CPD M (SD) = 26.18 (31.84)	1. Perinatal Wellness Navigator program (PWN; *n* = 50)	PWN[m] program consisting of: 1. SCRIPT[n] program - Quit guidebook and DVD + group counselling based on 5As 2. Addressing individual barriers to cessation

TABLE 1 (Continued)

Author (year) country	*Study Type*	*Recruitment setting and participant characteristics*	*Baseline tobacco smoking*	*Treatment groups (n)*	*Intervention strategies*
Waller C. et al. (1996) [25] USA	Single-arm program evaluation	Setting: Community clinic - Prenatal Substance Use Prevention Program (PSUPP) Participants: High-risk, chemically dependent pregnant women. (substance use characteristics not described)	High risk smokers (>5 CPD) *n* = 418 Medium risk smokers (<5 CPD) *n* = 96	1. Indiana PSUPP^{o} (*n* = 514)	PSUPP consists of: 1. Education on risks of smoking around baby and importance of quitting at initial visit + development of education/ counselling plan 2. Support and reinforcement of abstinence by staff (medical record prompts) during clinic encounters 3. One-on-one education sessions + individual referrals at subsequent visits
Kurti A. Un-published data [26] USA	Single-arm pilot study	Setting: High-risk pregnancy clinic at University Medical Centre Participants: Pregnant women receiving OAT	CPD M (SD) = 15.3 (8.8)	1. Financial incentives (n = 15)	1. Financial Incentives (using an escalating incentive schedule with a reset contingency) contingent on CO verified gradual smoking reductions for 12-weeks then cotinine verified abstinence until 12-weeks postpartum 2. 3 x brief counselling sessions based on 5As 3. Printed educational materials

TABLE 1 (Continued)

Author (year) country	*Intervention duration and FU[a] (n)*	*Objectives*	*Outcomes*	*Results*	*EPHPP quality rating*
Tuten M. et al. (2012) [16] USA Previously reviewed [5]	12 weeks FUs - 1-month post- intervention (n = not stated) 3 months post- intervention (n = not stated) 6-weeks postpartum (n = not stated)	1. Primary - to evaluate feasibility and efficacy of a CBI shaping schedule compared to NCBI and TAU for reducing cigarette smoking in pregnant women with SUD. 1. Secondary - to examine birth outcomes among the three conditions.	Primary: 1. Mean CO values across 12-week intervention 2. Proportion meeting behavioural smoking 75% reduction and abstinence targets 3. Self-reported CPD at 1 month, 3 months, and 6 weeks postpartum Secondary: 4. Voucher earnings for CBI and NCBI groups 5. Maternal and neonatal outcomes: proportion of LBW[i]; <2500 g) infants, preterm deliveries, mean birth weight, APGAR scores, hospital stay length	1. CBI group submitted lower mean COs than the NCBI and TAU across the intervention ($F = 18.05$, $P < 0.0001$). Mean CO for CBI group CO decreased from 12.1 at baseline to 4.0 at week-12 and was lower than the NCBI (8.7) and TAU (8.4) groups at week-12, but not significantly. 2. CBI group - 48% met 75% reduction target, 31% were abstinent (CO < 4 ppm) at week 12. TAU group - 2% met 75% reduction, none met abstinence targets. NCBI group – None met 75% reduction or abstinence targets. 3. Previous 24-hour mean CPD differed between CBI and TAU groups (9.3 vs 15.3, $P < 0.0001$). No difference between CBI and NCBI groups. Mean CPD at 1-month and 3-months differed between CBI and TAU (10.0 vs 17.0, $P = 0.016$) and (8.7 vs 16.9, $P = 0.008$) respectively, but not CBI and NCBI groups. CBI group CPD less than TAU and NCBI group CPD at 6-weeks postpartum (10.7 vs 14.0 and 17.8 respectively) but not significantly. 4. No difference in voucher earnings between CBI and NCBI groups. Mean total vouchers were $156.85 (range: $0–$736) and $96.98 (range: $0–$384) respectively. 5. Lower proportion of CBI group babies born pre-term compared to NCBI and TAU groups (17%, 25% and 29% respectively) and	Selection Bias: Moderate Study Design: Strong Confounders: Strong Data Collection Method: Strong Withdrawals and Dropouts: Weak Global Rating: MODERATE

(Continues)

TABLE 1 (Continued)

Author (year) country	*Intervention duration and FU[a] (n)*	*Objectives*	*Outcomes*	*Results*	*EPHPP quality rating*
				LBW (20%, 38% and 43% respectively). Not significant but clinically relevant.	
Holbrook A. et al. (2011) [18] USA Previously reviewed [5]	6 weeks FUs - 1-month post intervention (n = not stated) 3-months post intervention (n = not stated)	Compare pregnant and parenting women in terms of: 1. Effectiveness of intervention in reducing cigarette consumption 2. Factors associated with successfully reducing or eliminating cigarette consumption	1.Change (%) in CPD from Wk1 of intervention to 1-month FU and 3-month FU 2. Determine factors that predict smoking outcomes at 1-month FU and 3-month FU using multivariate regression 3. Determine group differences on % change in CPD from beginning to 1-month FU and 3-month FU and group satisfaction using MANOVA	1. No between group differences in CPD at treatment end or 1- or 3-month FU. Mean CPD decreased from Week 1 to 3-month FU for both groups – 49% (pregnant 15.2 vs 7.9) vs 32% (parenting 12.4 vs 8.5). 2. Pregnant women – a greater % decrease in CPD before start of intervention (b = −0.12; *P* = 0.01) and higher CPD at the start of the intervention (b = −1.33; *P* = 0.001) predicted smaller decreases in CPD at 1-mth f/up. Greater satisfaction with intervention was associated with smaller decreases in CPD at 1-mth FU (b = −12.6; *P* = 0.05). Higher cravings were associated with a smaller decrease in CPD at 1-mth FU (b = −2.13; *P* = 0.03). At 3-mth FU, satisfaction with the intervention predicted CPD (b = −69.35; *P* = 0.04). 3. No significant differences between pregnant and parenting groups on % decrease in CPD from baseline at the 1-month FU (45% vs 30%, f = 0.18; *P* = 0.67) or 3-mth FU (48% vs 31%, f = 0.03; *P* = 0.87). No significant between group differences found on satisfaction with the intervention (f = 1.46; *P* = 0.21)	Selection Bias: Moderate Study Design: Moderate Confounders: Weak Data Collection Method: Strong Withdrawals and Dropouts: Weak Global Rating: WEAK
Haug N. et al. (2004) [17] USA	6 weeks FU – 10 weeks post intervention (*n* = 54, 86% completion)	1. Determine if MET is more effective for smoking cessation than SC	1. Intervention effects - CPD, CO (cut-off 8 ppm) and urine cotinine	1. No difference between MET and SC on CPD, CO, or cotinine at FU.	Selection Bias: Moderate Study Design: Strong

(Continues)

TABLE 1 (Continued)

Author (year) country	*Intervention duration and FU[a] (n)*	*Objectives*	*Outcomes*	*Results*	*EPHPP quality rating*
Previously reviewed [5,19]	Difference between completers and lost to FU was Methadone dose (50.8 mg vs 36.3 mg, t(61) = −6.34, $P < 0.0001$)	2. Assess likelihood of MET participants to move forward in stages-of-change than SC group	2. Stage of Change (Treatment × stage × time ANOVA on CPD, CO and cotinine). 3.Stage of Change movement	2. CPD: decrease baseline to FU, F (1, 54) = 14.01, $P < 0.0001$. CO: increase baseline to FU, F (1, 50) = 10.32, $P < 0.002$. Cotinine: increase baseline to FU, F (1, 49) = 5.94, $P < 0.019$. (CPD, CO or cotinine means not reported) 3. 57% stayed in same stage of change, 25% moved forward, 17% moved back. MET group more likely to more forward (35% vs. 15%) and SC group more likely to move back (30% vs. 4%) $X^2(2, N = 53) = 7.39$, $P < 0.03$.	Confounders: Strong Data Collection Method: Strong Withdrawals and Dropouts: Strong Global Rating: STRONG
Ker M. et al. (1996) [20] USA Previously reviewed [19]	Variable – for length of stay in facility (approx. 9–12 months) No FU	1. To assess whether program can help women to attain higher stages of readiness to quit tobacco smoking 2. To determine whether the program is helping women to reduce or quit smoking 3. To assess clients' reactions to the ISC program	1. Progression to a higher stage of readiness to quit 2. Reductions in or abstinence from smoking 3. Acceptability of the program	1. No comparison of stage of change data was made between groups (data not collected for comparison group), but both groups rated the likelihood they would be smoking in one year (0='absolutely certain I will be smoking' and 9='absolutely certain I will not be smoking'). Mean score for comparison group was 2.0 ('very certain will be smoking'), and for treatment group 5.6 ('relatively certain will not be smoking') (t = −2.54, d.f. = 14, $P = 0.02$). 2. Average daily CO levels were almost at non-smoker levels in the treatment group and much lower than those of the comparison group (no means reported). Decrease in tobacco use - treatment group reported they used tobacco an average of 18.5 days out of the prior 30 at intake, and 5.3 days out of the	Selection Bias: Moderate Study Design: Weak Confounders: Weak Data Collection Method: Strong Withdrawals and Dropouts: Weak Global Rating: WEAK

(Continues)

TABLE 1 (Continued)

Author (year) country	*Intervention duration and FU[a] (n)*	*Objectives*	*Outcomes*	*Results*	*EPHPP quality rating*
				prior 30 at 3-months (F = 7.69, d. f. = I,28, *P* = 0.01). 3. Treatment program appeared to be attractive to participants. Focus groups reported overall positive feedback. Measures of withdrawal symptoms (used to assess long-term distress and impact on cessation)	
Fallin-Bennett A. et al. (2019) [24] USA	3 months FU – 3 months from initial visit (*n* = 38, attrition 76% completion)	1. Assess impact of PWN on smoking during pregnancy and early postpartum. 2. Quantify service referrals that reduce barriers to cessation + evaluate impact of PWN program on barriers to cessation (e.g. depression, stress).	Primary:1. CO verified smoking Secondary: 1. Nicotine dependence2. Self-reported CPD3. Motivation and confidence to quit 4. 2nd-hand smoke exposure (in home). Additional:1. Maternal psychosocial factors: Depression/anxiety, stress and recovery capital3. Referrals for services	Primary: CO decreased but not significantly (M = 19.12 to M = 17.39, *P* = 0.53). Secondary: Nicotine dependence reduced (M = 5.16 to M = 3.43, *P* < 0.01) CPD (past 30 days) reduced (M = 26.18 to M = 16.16, *P* = 0.05) Motivation and confidence to quit increased but not significantly (M = 6.04 to M = 7.03, *P* = 0.36; M = 3.66 to M = 4.35, *P* = 0.10 respectively) 2nd-hand smoke exposure increased overall, (52% baseline vs. 39.47% post intervention) with those reporting no exposure at home in past 7 days decreasing (M = 53.06 to M = 46.88, *P* < 0.01). Additional: Depression/anxiety decreased (M = 12.04 to M = 9.47, *P* = 0.03), Stress decreased (M = 6.78 to M = 5.30, *P* = 0.03). Recovery capital increased slightly (M = 42.46 to M = 43.97, *P* = 0.09) 124 referrals to reduce quit barriers (mainly for smoking cessation classes, then counselling/social work and contraception)	Selection Bias: Weak Study Design: Moderate Confounders: Weak Data Collection Method: Strong Withdrawals and Dropouts: Weak Global Rating: WEAK

TABLE 1 (Continued)

Author (year) country	*Intervention duration and FU[a] (n)*	*Objectives*	*Outcomes*	*Results*	*EPHPP quality rating*
Waller C. et al. (1996) [25] USA	Variable - from program enrolment to delivery No FU	1. Assess reductions in or abstinence from smoking 2. Program acceptability	1. Comparison of self-reported CPD at PSUPP entry and at end of pregnancy (delivery) 2. Satisfaction survey assessing tobacco use, perceived level of risk of tobacco use, knowledge gained, program satisfaction and number of visits to PSUPP staff	1. Comparison of CPD at PSUPP entry and delivery indicated 49.9% had decreased or abstained from smoking. 70.3% of high-risk smokers (>5CPD) had cut down or abstained. 2. Satisfaction survey (*n* = 131): Tobacco use - 26.7% reported stopping tobacco use, 17.5% reduced, 3.8% planned to reduce using information provided. Risk awareness (n = 64): 80% 'strongly agreed' that tobacco can harm an unborn baby, 66.2% 'strongly agreed' that smoking causes LBW in babies. Knowledge gained (*n* = 64): 55.7% received information that reinforced importance of prenatal care, 58% increased their general health status, 67.2% believed they would have a healthier baby. Program satisfaction (n = 64): 79.7% indicated the program was 'very helpful', 76.2% knew 'very much more' about tobacco. PSUPP visits (*n* = 116): 88 (75.9%) visited ≥2 times. 22 (19%) had visited ≥4 times.	Selection Bias: Moderate Study Design: Weak Confounders: Weak Data Collection Method: Weak Withdrawals and Dropouts: Weak Global Rating: WEAK Global Rating: WEAK
Kurti A. Un-published data [26] USA	Variable - from study enrolment to 12-weeks postpartum. No FU	1. To assess whether incentivizing gradual reductions in smoking rather than complete abstinence would be more effective in pregnant, opioid dependent women. 2. Women earned incentives for gradual reductions over a 12-week period, after which incentives were contingent on smoking abstinence	Primary: % who achieved abstinence verified by cotinine (< 80 ng/ml Secondary: 1. Highest % reduction target achieved 2. CPD at last goal met 3. % reduction in CPD at last goal met	Participants achieving smoking abstinence = 0 Highest reduction target achieved (Participant %): 10% target = 7%; 25% target = 7%; 50% target = 47%; 75% target = 27%; 100% target (<4 ppm) = 13% Overall average CPD at last goal met = 7 Overall average reduction in CPD achieved at last goal met = 48.5%	

(Continues)

TABLE 1 (Continued)

Author (year) country	Intervention duration and FU[a] (n)	Objectives	Outcomes	Results	EPHPP quality rating
				Average gestational age at last goal met = 26.8 weeks Conclusion drawn: Other financial incentives trials for pregnant smokers done in the same lab generate quit rates at late pregnancy of ~ 37% in non-opioid dependent pregnant smokers; it appears to be ineffective in opioid-dependent women.	

[a]Follow up; [b]Randomised controlled trial; [c]Opioid agonist treatment; [d]Cigarettes smoked per day; [e]Contingent behavioural incentives; [f]Non-contingent behavioural incentives; [g]Treatment as usual; [h]Carbon monoxide; [i]Low birth weight; [j]Cessation framework—ask, assess, advise, assist, arrange; [k]Motivational enhancement therapy; [l]Standard Care; [m]Perinatal Wellness Navigator; [n]Smoking Cessation and Reduction in Pregnancy Treatment; [o]Prenatal Substance Use Prevention Program.

[18]. No differences in CPD at treatment end or follow-ups were identified. Overall self-reported CPD reduced in pregnant women, with some reported abstinence, but supporting data was absent. Lower pre-intervention nicotine use and cigarette cravings predicted successful reduction in smoking, but greater intervention satisfaction predicted smaller reductions.

Ker et al. [20] assessed an incentive-based involuntary smoking cessation program in pregnant women attending a smoke-free residential rehabilitation facility. Smokers' CO levels reduced to non-smokers' levels and were lower than those from a comparison facility, although no statistics were provided. Program-leavers' motivation to quit was significantly higher than their comparison counterparts.

DISCUSSION

This review identified seven studies that examined smoking cessation in pregnant women with substance use concerns, adding three studies to the four described in previous reviews. All interventions provided at least two evidence-based cessation strategies including an educational component. However, studies varied in terms of methodology, treatment strategies and outcomes, making conclusions about effective treatment approaches for this group difficult. Only one demonstrated abstinence in their CM-based treatment group compared to controls, although this was not sustained post-treatment [16].

Such results highlight the need for research that overcomes the limitations of these studies and emphasises the barriers associated with maternal AOD treatment. Tuten et al. v [16] suggested that future treatments incorporate longer treatment durations to counter high rates of post-treatment relapse. Investigators of the unpublished study [26] proposed that CM may be less effective for opioid-dependent women after achieving quit rates averaging 37% in CM programs for non-opioid-dependent pregnant smokers [27]. Consumer perspectives on facilitators of smoking abstinence may provide future solutions, and researchers should consider specific challenges including responding to high levels of nicotine dependence, psychosocial complexity and other substance use treatment in this group.

Five studies showed cigarette consumption reductions ranging from 37% to 71% at the longest follow-up. Maternal smoking reduction is often rejected by health experts because it may increase compensatory smoking [28] and deter women from accepting cessation support [29]. However, reductions in tobacco-related harm such as improvements in women's health and neonatal outcomes identified here are valuable by-products of treatment participation [30] and their educational value and potential to assist future attempts should be considered.

The review revealed some notable weaknesses, including a concentration of US-based studies, impacting generalisability because of diverging AOD treatment paradigms across countries. Research quality and rigor was also lacking. The methodological heterogeneity, low quality, inconsistent/missing data and limited sample sizes of studies

precluded a meta-analysis, making conclusions about treatment effectiveness challenging. Rigor and supporting evidence are necessary for evaluating smoking treatments, especially in groups where underreporting of CPD because of stigma and fear is elevated [31].

Only one study offered pharmacological and behavioural support [20], an effective combination in non-maternal populations [32]. Limited evidence for NRT in pregnancy populations may have deterred its inclusion in these studies. No interventions included e-cigarettes as a cessation aid, potentially because of their emerging status and lack of evidence in pregnancy. Additionally, no studies targeted women in treatment for alcohol dependence, reflecting the general paucity of treatments for maternal alcohol dependence and the need for research on how to better engage this group in treatment [33].

CONCLUSION

This review identified tobacco smoking cessation interventions trialled in pregnant women with AOD concerns; however, the heterogeneity of interventions and lack of rigor hindered conclusions regarding effective approaches. Evidence of abstinence was scarce, but significant reductions in cigarette consumption were achieved using effective general-population strategies and these were associated with a range of positive outcomes. The review highlights the shortage of interventional studies and the difficulty in achieving lasting abstinence in this complex, high-priority group.

Further intervention development is needed with consistent outcome measurements and rigorous testing methods that allow meaningful synthesis. Examination of combined behavioural and pharmacological strategies with consumer input is also recommended.

DECLARATION OF INTERESTS

None.

AUTHOR CONTRIBUTIONS

Melissa Jackson: Conceptualization; formal analysis; methodology; project administration; validation. **Amanda Baker:** Conceptualization; supervision; visualization. **Gillian Gould:** Conceptualization; methodology; supervision; visualization. **Amanda Brown:** Conceptualization; supervision; visualization. **Adrian Dunlop:** Conceptualization; supervision; visualization. **Kristen McCarter:** Formal analysis; methodology; validation.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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