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REVIEW ARTICLE

EFFICACY OF FINANCIAL INCENTIVES IN AIDING SMOKING CESSATION AMONG PREGNANT WOMEN: A SYSTEMATIC REVIEW AND META-ANALYSIS

*Subhashree Mohapatra, Rahul Mohandas**

Dr. D. Y. Patil Dental College and Hospital, Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune, India

*Correspondence: rahuldas1192@gmail.com

ABSTRACT

BACKGROUND:

Research on the use of financial incentives in tobacco cessation is an emerging field that is based on the concept that providing rewards or reinforcers will increase the chance of drug-avoiding behavior. The current systematic review aimed to assess the available literature on the effectiveness of financial incentives in smoking cessation among pregnant women.

MATERIALS AND METHODS:

The earliest date accessible up until November 30, 2023, was thoroughly searched in databases including Scopus, PubMed, Cochrane, Science Direct, LILACS, ScienceDirect, Web of Science, and Google Scholar. The review only comprised randomised controlled trials. Six full-text publications that met the requirements for eligibility underwent additional processing for data extraction, qualitative and quantitative analysis.

RESULTS:

The meta-analysis showed that financial incentives are more effective as compared to counselling alone in aiding smoking cessation among pregnant women with a 95% CI of odds ratio (OR): 2.59 [2.05, 3.26]; P=0.51; Test for heterogeneity: P<0.00001; I2=0%.

CONCLUSION:

Financial incentives along with tobacco cessation counselling were found to be beneficial when it comes to helping pregnant smokers quit. However, in the postpartum period, a decrease in the cessation rates was observed. Therefore, the long-term effectiveness of financial incentives in smoking cessation needs to be assessed.

KEYWORDS

incentive, smoking cessation, pregnant women

INTRODUCTION

Smoking during pregnancy raises the risk of several acute and long-term health issues for both the mother, such as a higher chance of pre-eclampsia, placental anomalies, and early membrane rupture, [1] and the unborn child, such as increased risk of birth abnormalities, premature birth, low birth weight, and higher incidence of unexpected infant mortality. [2] While

women who smoke during pregnancy may lose up to ten years of life, those who permanently quit will have an almost normal lifetime. [3]

According to a study conducted by Lange et al, The prevalence of smoking during pregnancy was found to be 8·1% (95% CI 4·0–12·2) in the European Region, 5·9% (3·2–8·6) in the Americas Region, 1·2% (0·7–1·7) in Southeast Asia, 1·2% (0·0–3·7) in the Western Pacific Region, 0·9% (0·0–1·9) in the Eastern Mediterranean Region, and 0·8% (0·0–2·2) in the African Region. Across the globe, daily smokers constituted 72·5% (95% CI 70·4–75·0) of pregnant women who smoked. [4] This implies that smoking while pregnant is still a common practice in many nations. These results highlight the need for better access to smoking cessation programs for expectant mothers as well as initiatives for health promotion and smoking prevention.

Both the percentage of pregnant smokers who use cessation therapies and the success rate of most cessation programs for pregnant women (6%) are low. [5] The US Preventive Services Task Force concluded that while behavioral therapies are very beneficial in helping people quit smoking, there is not enough data to determine the risks and benefits of pharmacological interventions. [6] A recent Cochrane review indicated that nicotine replacement therapy increased the likelihood that pregnant women will stop smoking. However, this data is not very reliable because the impact did not persist when non-placebo controlled randomised controlled studies were removed from the analysis. Also, there is little evidence to support the claim that nicotine replacement treatment affects birth outcomes, namely birth weight. [7] Therefore, research into new treatment options is necessary to assist pregnant smokers in quitting. [8]

Based on the hypothesis that offering rewards or reinforcers will enhance the likelihood of drug-avoiding behavior, a new field of research is exploring the use of financial incentives in tobacco cessation. [9] According to a theory, financial incentives may function through operant conditioning behavioral processes (positively rewarding the desired behavior) or by offering short-term gain for behavior change that, although perceived as less proximal to the individual, ultimately results in long-term gain (delay discounting). [10] Encouragement to join the program, process compliance, and quitting at predetermined stages can all be rewarded with incentives. These rewards are typically only granted if a biochemically-confirmed cessation outcome is produced. [10] For these goals, a range of rewards have been employed, such as cash payments, salary bonuses, vouchers exchangeable for commodities (apart from alcohol and cigarettes), leisure activities, or promotional items like bags, pens, and T-shirts. [11]

A mixed methods study [12] and several clinical studies [13,14,15] have suggested that financial incentives would be suitable to help smoking cessation during pregnancy. However, there is a dearth of systematic review evaluating the efficacy of financial incentives in helping pregnant women quit smoking. Hence, the aim of this review is to assess and compare the available data on the effectiveness of financial incentives in smoking cessation among pregnant women.

MATERIALS AND METHODS

The systematic review was conducted in compliance with the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines. [16]

STUDY REGISTRATION

The protocol and study details have been registered in PROSPERO. (Registration number: CRD42023492333).

FOCUSED QUESTION

What is the effect of financial incentives on smoking cessation compared to standard therapy among pregnant women?

PICO ANALYSIS

Population: Pregnant women**; Intervention:** Financial incentives**; Comparator:** Standard therapy**; Outcome:** Smoking cessation

SEARCH STRATEGY

A comprehensive search was carried out from the earliest date possible to November 30, 2023, across databases such as PubMed, Cochrane, Scopus, Lilacs, ScienceDirect, Web of Science, and Google Scholar in order to find pertinent materials. To locate further publications, a manual search of important journals, conference proceedings, unpublished articles, and cross-references was carried out. The authors were notified if the papers were not published. The specific search strategies used for each database are detailed in Table 1.

TABLE 1: SEARCH STRATEGIES FOR VARIOUS DATABASES

Database	Search string
PubMed	(("Financial Incentives"[MeSH] OR "financial incentive" OR "monetary reward" OR incentive-based) AND ("Smoking Cessation"[MeSH] OR "smoking cessation" OR "quit smoking" OR "tobacco cessation") AND ("Pregnancy"[MeSH] OR "Pregnant Women"[MeSH] OR pregnant women OR expectant mother OR pregnancy))
Cochrane Library	(["Financial Incentives"] OR "financial incentive*" OR "monetary reward") AND (["Smoking Cessation"] OR "smoking cessation" OR "quit smoking") AND ([Pregnancy] OR ["Pregnant Women"] OR pregnant women OR expectant mother OR pregnancy)
Scopus	TITLE-ABS-KEY ("financial incentive" OR "monetary reward" OR incentive-based) AND ("smoking cessation" OR "quit smoking" OR "tobacco cessation") AND ("pregnant women" OR "expectant mother" OR pregnancy)
Lilacs	(("financial incentive" OR "monetary reward'') AND ("smoking cessation" OR "quit smoking") AND ("pregnant women'' OR "pregnancy"))
ScienceDirect	("financial incentive" OR "monetary reward" OR incentive-based) AND ("smoking cessation" OR "quit smoking") AND ("pregnant women" OR "expectant mother" OR pregnancy)
Web of Science	TS=("financial incentive" OR "monetary reward" OR incentive-based) AND TS=("smoking cessation" OR "quit smoking") AND TS=("pregnant women" OR "expectant mother" OR pregnancy)
Google Scholar	"financial incentive" OR "monetary reward" "smoking cessation" "pregnant women"

INCLUSION CRITERIA

- Studies on pregnant women
- Study design: Randomized controlled trials (RCTs)
- Studies comparing the effectiveness of financial incentives with standard therapy in smoking cessation
- Articles available in English language

EXCLUSION CRITERIA

- Articles assessing the effectiveness of financial incentives as a secondary outcome
- Case reports, cross-sectional studies, longitudinal studies, case-control studies, cohort studies, feasibility studies, in-vitro studies, and reviews

SOURCES USED

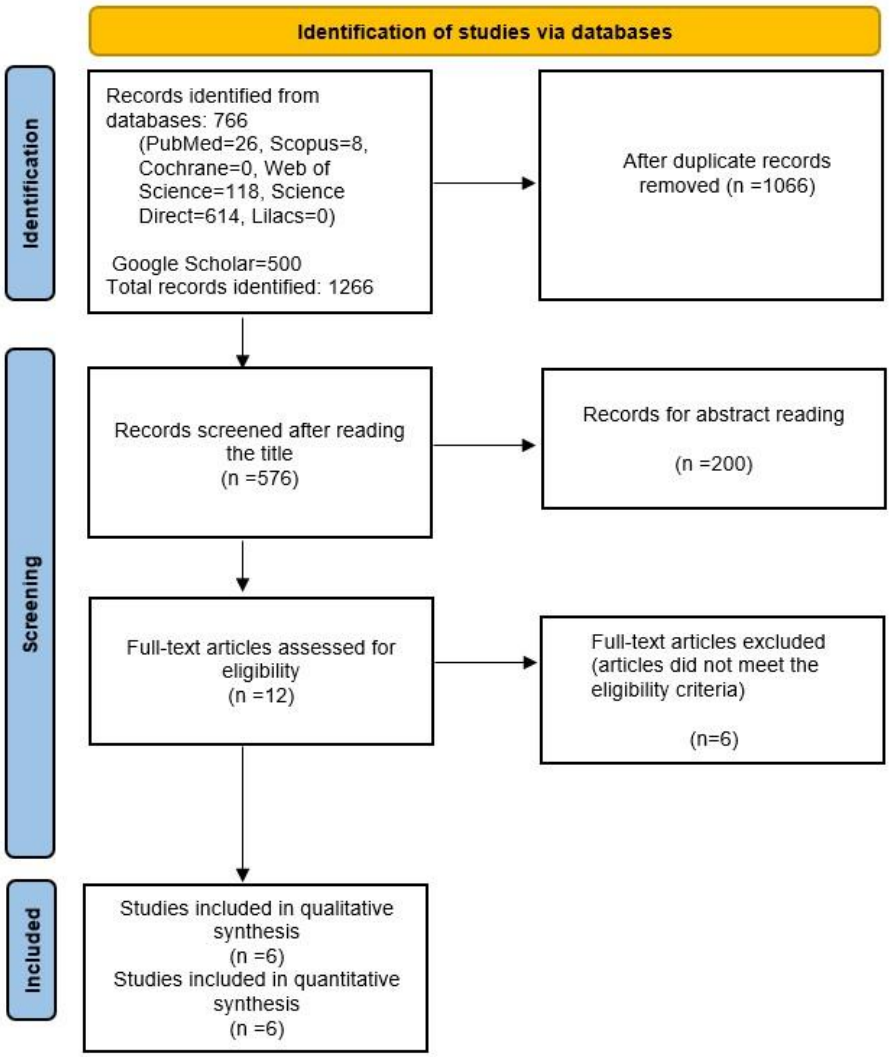
PubMed, Scopus, Cochrane, Web of Science, LILACS, ScienceDirect, Google Scholar

SCREENING AND SELECTION

The reviewers (SM and RM), perused the study titles independently. If the same articles were found in multiple databases, they were excluded due to duplication. Titles and abstracts were screened to assess their relevance to the review

question. Articles that met the inclusion criteria, or for which eligibility could not be clearly determined, were selected for full-text review. After retrieving the full-text documents, their eligibility was assessed. If the papers satisfied the eligibility conditions, they underwent additional processing for data extraction (Figure 1). The reference lists of the full-text articles were manually scanned to locate other studies.

FIGURE 1. PRISMA FLOWCHART



DATA EXTRACTION

The following details were gathered independently by two reviewers and entered into an Excel spreadsheet (MS Excel 2020): author details, study year, study location, study design, participant demographics, intervention, outcome assessed, study duration, financial incentives provided, outcome, and inference of the included study. English translations of publications written in other languages were made with Google Translate. [17] The appropriate authors were contacted to obtain the full texts or any missing information where full-text publications were not accessible. Discussions were used to settle disagreements.

RISK OF BIAS ASSESSMENT

The risk of bias both within and across the included studies was assessed using the Cochrane Risk of Bias tool (version 1). [18] The bias was categorized as "high risk," "unclear risk," or "low risk" based on the following components: random sequences generation, the concealment of allocation, the blinding of participants and personnel, the blinding of outcome assessment, the incomplete outcome data, the selective reporting, and other factors.

A study was classified as "low risk" if all of the prerequisites were satisfied. A study was classified as "high risk" if any one of the requirements was satisfied. A study was categorized as having "unclear risk" if one criterion was "unclear risk" and no other criterion was "high risk." Disagreements were settled by consensus.

QUALITY OF EVIDENCE

The included studies' level of evidence was assessed using the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) Assessment Tool. [19] Four categories were used to classify the evidence's quality: very low, low, moderate, and high. The GRADE categories of risk of bias, imprecision, consistency, indirectness, and publication bias were employed to assess the quality of the evidence.

DATA ANALYSIS

For qualitative synthesis, the resulting data was entered into the data extraction table, and for quantitative synthesis, meta-analysis was conducted after that. The difference in outcome between the financial incentive group and the standard therapy group was evaluated using a random effect model. A random-effects model was chosen a priori to account for potential clinical and methodological differences between studies, such as variations in incentive type, participant characteristics, and outcome assessment, regardless of the observed level of statistical heterogeneity. The odds ratio at a 95% confidence interval (CI) was estimated using the total number of events and participants in each group. To evaluate the heterogeneity among the results of the included studies, the I2 statistic and Chi-square tests were employed. If the p value was less than 0.1, heterogeneity was deemed statistically significant. Review Manager 5.4.1 was used to carry out the statistical analysis. Subgroup analyses were planned in advance; however, they were not undertaken because statistical heterogeneity was minimal (I^2 = 0%), and the small number of included studies meant that any subgroup comparisons would have been underpowered and potentially misleading.

RESULTS

SEARCH AND SELECTION OF RESULTS

A total of 766 records were retrieved from electronic databases, including PubMed, Scopus, Cochrane Library, LILACS, ScienceDirect, and Web of Science. Due to the very large number of results from Google Scholar and the rapid decline in relevance beyond the first few hundred entries, the first 500 most relevant Google Scholar records were screened, following recommended systematic review practices. After removing duplicates, a total of 1066 unique records remained from all sources. Two reviewers (SM and RM) independently screened the titles to determine their relevance to the review question. Records were excluded at this stage if they were clearly irrelevant—for example, animal studies, reviews, non-English publications, studies not involving pregnant women, or studies not addressing financial incentives or smoking cessation. This initial screening reduced the pool to 200 records for abstract review.

The abstracts were then independently evaluated for eligibility. Studies were excluded if they did not assess financial incentives for smoking cessation, were not randomized controlled trials, included non-pregnant populations, or did not report relevant outcomes. Following this step, 12 studies were selected for full-text retrieval.

Full-text articles were carefully reviewed against the inclusion criteria. Studies were excluded if they did not meet the study design requirements, lacked sufficient outcome data, or did not focus on the target population or intervention. Ultimately, 6 studies met all criteria and were included in the final analysis (Table 2). Additionally, reference lists of the included studies were manually checked to identify any further relevant articles.

TABLE 2: CHARACTERISTICS OF INCLUDED STUDIES

Name of author, year	Place of study	Type of study	Participant description	Intervention	Outcome assessed	Study duration	Financial incentive given to the participants	Outcome	Inference
Tappin et al, 2022 [20]	Scotland	Single-blinded phase III RCT	Sample size: 944 Mean age: 27.9 years	Intervention group: tobacco cessation counselling + financial incentives (n=472) Control group=tobacco cessation counselling+ offer of NRT (n=472)	Breath carbon monoxide levels and saliva cotinine levels	For at least 8 weeks in late pregnancy (34-38 weeks of gestation) and 6 months post-partum	Up to £400 shopping vouchers	During pregnancy 27% participants stopped smoking from the intervention group and 12% from the control group (adjusted odds ratio 2.78 (1.94 to 3.97) P<0.001). Post-partum 5.7% were non-smokers in intervention group and 4.4% from control group 6 months post-partum	Incentive-based interventions are successful in helping pregnant smokers quit.
Kurti et al, 2022 [21]	Burlington	RCT	Sample size:90 Mean age: 31.63 years	Intervention group: tobacco cessation counselling + remote financial incentives using mobile app (n=42) Control group: only tobacco cessation counselling (n=48)	Self-reported 1 week abstinence + salivary cotinine levels	Assessment before treatment assignment An early pregnancy assessment: 1 month after treatment assignment A late pregnancy assessment at ≥ 28-weeks gestation), and at 4-, 8-, 12-, and 24-weeks postpartum	Average incentive: $330.52± $446.18	Individuals assigned to intervention group had nearly 4-fold greater odds of smoking abstinence across antepartum and postpartum assessments compared to control group ($\chi^2_1 = 6.96$; adjusted odds ratio, 3.82; 95% CI, 1.63-8.92; $P = .008$)	Pregnant smokers can successfully quit with incentive-based interventions

Berlin et al, 2021 [22]	France	Single-blinded RCT	Sample size: 460 Mean age: 29 years	Intervention group: tobacco cessation counselling + financial incentives (n=231) Control group: tobacco cessation counselling; no financial incentives upon abstinence; only show up fees given (n=229)	Self-report of no smoking in the past 7 days and breath carbon monoxide levels	Visit 1: set quit date Visit 2-6: up to the expected delivery date	If the intervention group continued to abstain, they would receive a voucher worth €20, and further progressively increasing vouchers at each study visit All participants (intervention + control) received a €20 show-up fee at each of six visits.	During pregnancy The continuous abstinence rate was significantly higher in the intervention group (16%, 38/231) than control group (7%, 17/229) odds ratio 2.45 (95% confidence interval 1.34 to 4.49), P=0.004). The point prevalence abstinence rate was higher in intervention group as compared to control group (odds ratio 4.61, 1.41 to 15.01, P=0.011	Pregnant smokers who receive financial incentives for quitting are more likely to have abstained from smoking than those who do not.
Kurti et al, 2020 [23]	Burlington	RCT- pilot study	Sample size: 60 Mean age: 30.4 years	Intervention group: tobacco cessation counselling + remote financial incentives using mobile app (n=30) Control group: only tobacco cessation counselling (n=30)	Breath carbon monoxide levels and saliva cotinine levels	Assessment before treatment assignment An early pregnancy assessment: 1 month after treatment assignment A late pregnancy assessment at ≥ 28-weeks gestation), and at 4-, 8-, 12-, and 24-weeks postpartum	Average incentive: $411.47 ± $464.23.	During pregnancy 7-day point prevalence abstinence rates were greater in the intervention group as compared to control group Early- (46.7% vs 20.0%, OR=3.50, 95%CI=1.11,11.02) Late-antepartum (36.7% vs 13.3%, OR=3.76, 95%CI=1.04,13.65) Post-partum Significant findings at Four weeks postpartum (36.7% vs 10.0%, OR=5.21, 95%CI=1.28,21.24)	Incentive-based interventions are successful in helping pregnant smokers quit.

								Eight-weeks postpartum (40.0% vs 6.7%, OR= 9.33, 95%CI=1.87,46.68) Non-significant findings at 12 weeks postpartum (23.3% vs 10.0%, OR=2.74, 95%CI=0.63,11.82) 24- weeks postpartum (20.0% vs 6.7%, OR=3.50, 95%CI=0.65,18.98)	
Olson et al, 2019 [24]	New Hampshire	RCT	Sample size: 134 Age: not mentioned	Intervention group: tobacco cessation counselling + financial incentives (n=66) Control group=tobacco cessation counselling (n=68)	Urinary cotinine levels	Urinary cotinine levels assessed at any prenatal visit and at 6-to 8-week postpartum visit.	Each appointment included a $25 gift card if the patient did not smoke and their cotinine test came back negative. Furthermore, if their cotinine test came back negative and they did not smoke, they would get a $50 gift card during the 6- to 8-week postpartum appointment.	During pregnancy The quit rates during pregnancy did not differ between groups (Intervention 36.4%, Control 29.4%, p=0.46) Post-partum Significantly more mothers gave up smoking and maintained to abstain after giving birth in intervention group. (Intervention 31.8%, Control 16.2%, p=0.04) Odds ratio=3.48	Incorporating cotinine testing and financial incentives into current initiatives to help pregnant women quit smoking can improve the number of smokers who quit after giving birth.
Tappin et al, 2015 [25]	Scotland	Single-blinded phase II RCT	Sample size: 612 Age: 16 years and above	Intervention group: tobacco cessation counselling + financial	Cotinine levels assessed either through saliva or urine	Cotinine levels verified at 34-38 weeks of gestation	Up to £400 shopping vouchers	During pregnancy Significantly more smokers in the intervention group than control group stopped smoking: 69 (22.5%) vs 26 (8.6%).	Interventions based on incentives are successful in helping pregnant smokers quit.

				incentives (n=306) Control group=tobacco cessation counselling+ offer of NRT (n=306)					

TABLE 3: SOCIODEMOGRAPHIC CHARACTERISTICS OF THE PARTICIPANTS INCLUDED IN THE STUDIES

Study	Gestational age at first visit	Education /employment	Smoking status	Age of onset of smoking	Partner/family member with a habit of smoking	Level of addiction	Readiness to quit
Tappin et al, 2022 [20]	<24 weeks of gestation	Not mentioned	≤10 cigarette/day Intervention group: 59.7% Control group: 59.1%	Intervention group=14.7 ± 3.0 years Control group=14.8± 2.8 years	Intervention group=60.6% Control group=57.4%	Not mentioned	Not mentioned
Kurti et al, 2022 [21]	Intervention group=13.71± 5.44 weeks Control group=17.29± 5.30 weeks	More than 12 years of education Intervention group: 41% Control group: 44%	>10 cigarettes/day Intervention group:85% Control group:91%	Intervention group=15.83± 3.47 Control group=17.25± 3.80	Intervention group: 68% Control group: 58%	First cigarette within 5 mins of waking Intervention group=39% Control group=48%	Not mentioned
Berlin et al, 2021 [22]	< 18 weeks of gestation	Intervention group: 59% employed Control group: 65% employed	Past 7 days total cigarette count Intervention group: 56 Control group: 60	Intervention group=16.6 years Control group= 16.4 years	Intervention group=72% Control group=73%	Not mentioned	(scale 0-10) Intervention group=8.3 Control group= 8.4

Kurti et al, 2020 [23]	Intervention group: 14.9 ± 4.9 weeks Control group: 13.9 ± 4.3 weeks	More than 12 years of education Intervention group= 30% Control group= 50%	Total no. of cigarettes/day Intervention group= 19.0± 4.8 Control group=18.2 ± 5.5	Intervention group=15.4 ± 3.3 years Control group:15.6 ± 3.0years	Intervention group=73% Control group=70%	Not mentioned	Not mentioned
Olson et al, 2019 [24]	<12 weeks of gestation age	Intervention group=11.9 ± 2.2 years Control group=11.6 ± 2.2 years	Total no. of cigarettes/day Intervention group=17.2 ± 9.5 /day Control group=15.8 ± 7.5 /day control	Not mentioned	Not mentioned	Not mentioned	98.5% of the participants
Tappin et al, 2015 [25]	less than 24 weeks of gestation age	Not mentioned	>20 cigarette/day Intervention group:10.5% Control group: 17.1%	Not mentioned	Intervention group: 59.8% Control group: 66.3	First cigarette within 5 mins of waking Intervention group: 52.9% group Control group: 57.1%	Not mentioned

CHARACTERISTICS OF INCLUDED STUDIES

All the studies were randomised controlled trials [20-25]. One was a pilot study [23], one was a phase II trial [25], and one was a phase III trial [20]. In one study, both participants and the researcher were blinded [22]. In one study, researcher was blinded whereas no information was given for the participants [25]. In another study, participants were blinded but no information was given for the researcher [20]. No information regarding blinding of both, participants and researcher was given in three studies [21,23,24]. The mean age of the study participants in the included studies ranged from 25 to 31.63 years. The maximum sample size of the included studies was 944 and the minimum sample size was 60.

SOCIODEMOGRAPHIC CHARACTERISTICS

The minimum gestational age at the first visit was < 12 weeks [24] and the maximum was < 24 weeks [20,25]. In majority of the studies participants smoked more than 10 cigarettes/day except in two studies [20,22] where the participants smoked less than 10 cigarettes/day. The minimum mean age of onset of smoking was 14.7 years and the maximum was 17. 25 years. Majority of the participants had a partner or a family member with a habit of smoking. The level of addiction [21,25] and readiness to quit the habit [22,24] were assessed in only two studies. (Table 3).

PLACE OF STUDY

Two studies were conducted in Scotland [20,25], two in Burlington [21,23], one in France [22], and one in New Hampshire [24] respectively.

INDUSTRY FUNDING

The funding was acknowledged in all the studies. The studies were funded by the Scottish Government [25], The Dartmouth Clinical and Translational Science Institute [24], National Institute on General Medical Sciences [21,23], French National Cancer Institute [22], and Medical Research Council, United Kingdom [20].

INTERVENTION AND REGIMEN

In all the studies, the intervention group received both financial incentives and tobacco cessation counselling out of which in two studies [21,23], the participants received remote financial incentives. In all the studies, the control group received only tobacco cessation counselling. In two studies [20,25], the control group was also offered nicotine replacement therapy products. In one study [22], a show-up fee of €20 was given to the control group. Breath carbon monoxide levels were assessed in three studies [20,22,23]. Salivary cotinine levels were assessed in three studies [20,21,23], urinary cotinine levels in one study [24], and urinary or salivary cotinine levels in one study [25]. In one study [20], the outcome was assessed at 34 -38 weeks of gestation and 6 months post-partum. In one study [25], the outcome was assessed at 34-38 weeks of gestation only. In two studies [21,23], an early pregnancy assessment was done one month after treatment assignment, and a late pregnancy assessment was done at $\geq$ 28 weeks of gestation and at four months, eight months, 12 months, and 24 months post-partum. One study [22] had two-six follow up visits till the delivery date. In one study [24], assessment was done at any prenatal visit and six-to eight-week postpartum visits.

FINANCIAL INCENTIVES GIVEN

In three studies [20,22,25], incentives were given in the form of shopping vouchers. In one study [24], incentives were given in the form of gift cards whereas in two studies [21,23] the form of incentive was not mentioned.

STUDY OUTCOMES

During pregnancy

In all the studies, a higher number of participants stopped smoking who received both tobacco cessation counselling and financial incentives as compared to those who received only tobacco cessation counselling. The highest cessation rate among those who received financial incentives was 46.7% whereas for the control group was 29.4% [23]. The lowest cessation rate among those who received financial incentives was 16% whereas for the control group was 7% [22]. The findings were statistically significant in all the studies except for one study.

Post-partum

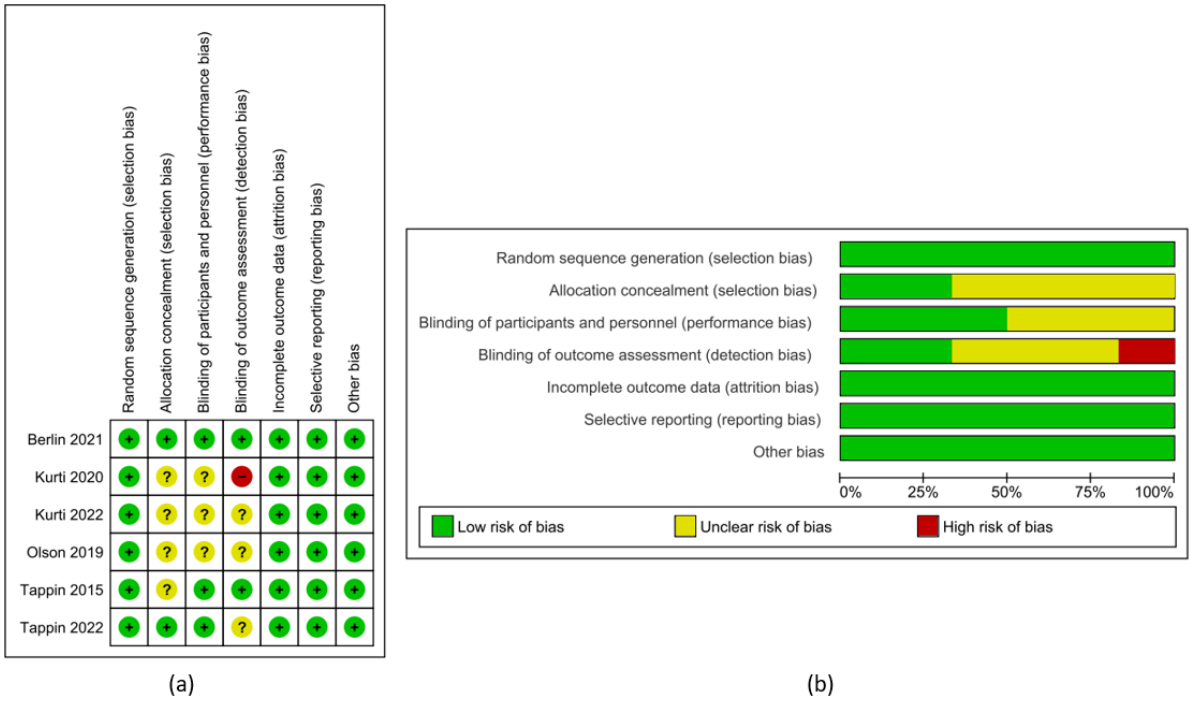
The post-partum tobacco cessation rate was assessed as a secondary outcome in four studies [20,21,23,24]. The tobacco cessation rates were found to decline from pregnancy to post-partum in all four studies. However, the cessation rate was higher in the intervention group as compared to the control group. The findings were significant in all the studies except in one study [23] where the findings for 12 weeks and 24 weeks post-partum were not statistically significant.

RISK OF BIAS

One study was rated as high risk [23], four studies were rated as unclear risk [20,21,24,25], and one study [22] was rated as low risk of bias. The risk of bias summary has been illustrated in Figure 2 (a).

Allocation concealment and blinding of outcome assessment exhibited a low risk of bias of greater than 25% but less than 50%. Blinding of personnel and participants exhibited a low risk of bias of 50%. No bias was seen in random sequence generation, incomplete outcome data, and selective reporting, and other bias. The risk of bias graph has been illustrated in Figure 2 (b).

FIGURE 2: (A) RISK OF BIAS SUMMARY (B) RISK OF BIAS GRAPH



(a) (b)

QUALITY OF EVIDENCE

The evidence quality was rated as "moderate" indicating that the true effect is probably not far from the estimated effect. The rating of "serious" was given to the risk of bias because one study [23] had a "high risk of bias" and four other studies [20,21,24,25] had an "unclear risk of bias." (Table 4).

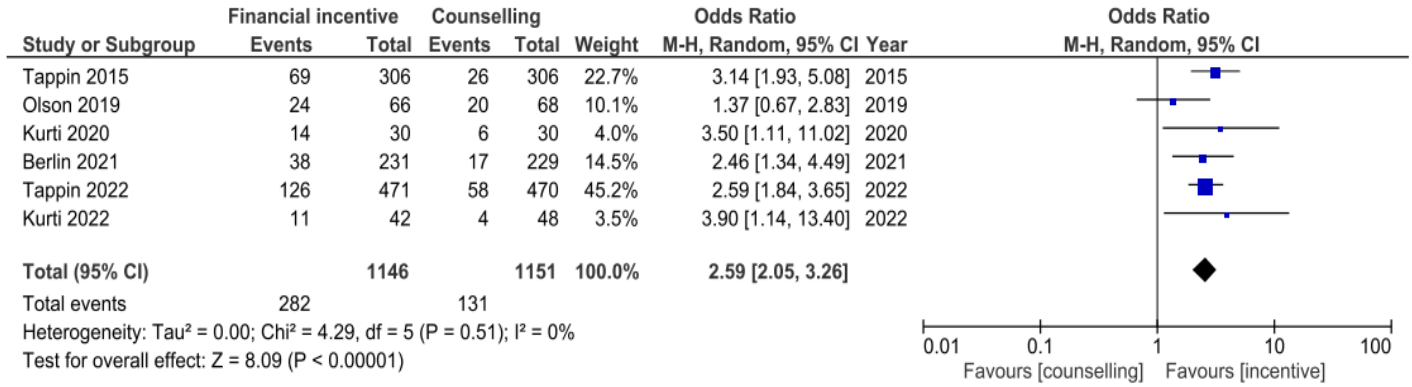
TABLE 4: QUALITY OF EVIDENCE

Certainty assessment							№ of patients		Effect		Certainty
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	[financial incentive]	[standard therapy]	Relative (95% CI)	Absolute (95% CI)	
6	randomised trials	serious	not serious	not serious	not serious	none	282/1146 (24.6%)	131/1151 (11.4%)	**OR 2.59** (2.05 to 3.26)	**136 more per 1,000** (from 95 more to 181 more)	⊕⊕⊕◯ Moderate

META-ANALYSIS

All six studies favored financial incentives over tobacco cessation counselling in smoking cessation among pregnant women. Overall, the meta-analysis showed that financial incentives are more effective as compared to counselling in aiding smoking cessation among pregnant women with a 95% CI of odds ratio (OR): 2.59 [2.05, 3.26]; P<0.00001; Test for heterogeneity: P=0.51; I^2=0% (Figure 3).

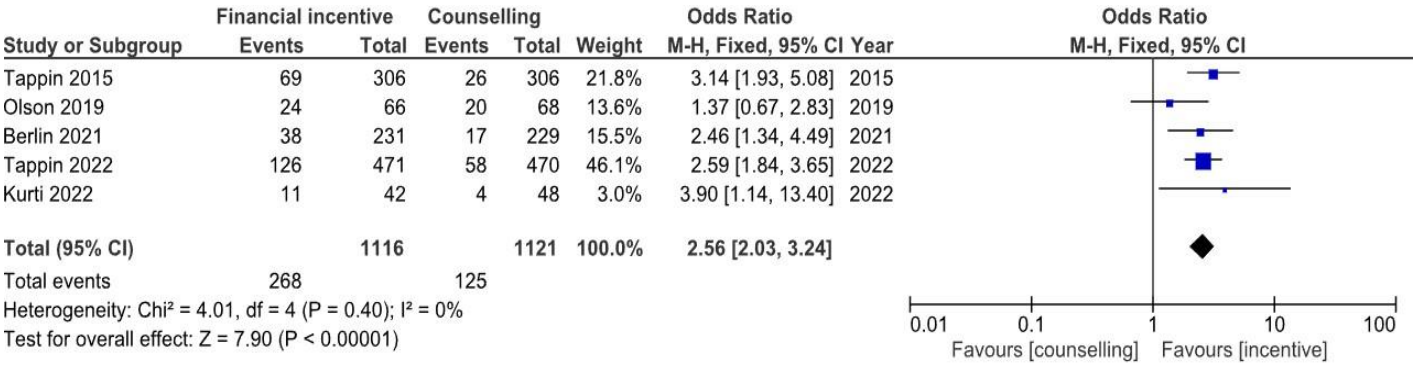
FIGURE 3: FOREST PLOT DEPICTING THE EFFECTIVENESS OF FINANCIAL INCENTIVES AND COUNSELLING



SENSITIVITY ANALYSIS

Sensitivity analysis excluding studies at high risk of bias [23] produced results consistent with the primary analysis, with financial incentives continuing to show a significant advantage over counselling (OR = 2.56, 95% CI 2.03–3.24; *P* < 0.00001). Heterogeneity remained minimal (I^2 = 0%; heterogeneity *P* = 0.40), supporting the robustness of the findings (Figure 4).

FIGURE 4: SENSITIVITY ANALYSIS



DISCUSSION

Globally, smoking is the primary cause of disease and mortality. [26] The majority of smokers wish to stop, yet it can be quite difficult to do so. The health of smokers can be significantly improved by quitting. Money or vouchers can be used as incentives to get smokers to stop and as rewards for sticking with it. In the current review, financial incentives along with tobacco cessation counselling were found to be effective in aiding smoking cessation among pregnant smokers as compared to tobacco cessation counselling alone. However, the cessation rates were found to decline in the post-partum period.

The quit rate in the intervention group was highest in the study conducted by Kurti et al [23] (46.7%). One possible explanation for the high percentage of quits could be that the incentive offered was greater compared to other studies. The study's findings also highlight the effectiveness of smartphone-based financial incentives in demonstrating how technology can be used to spread this effective, evidence-based treatment's reach and the possible positive effects on public health that could result from doing so.

The quit rate in the intervention group was the lowest in the study conducted by Berlin et al [22] (16%). The reason could be that the majority of the participants were living with a partner/family member who was a smoker. Another reason could be that the amount of incentive given was very low which would have reduced the desire to quit the habit. Although the quit rate was higher in the intervention group in the study conducted by Olson et al [24], the findings were insignificant. The participants may not have been sufficiently motivated to quit as they had simply been given a $25 gift card. Together, these observations suggest that the design and delivery of incentives may influence effectiveness; however, these inferences are drawn from comparisons between studies rather than from formal analyses within individual trials. Overall, while cessation outcomes varied across studies, the available evidence does not permit firm conclusions about a dose–response relationship between incentive magnitude and quitting success. Well-designed trials that directly compare different incentive levels within comparable populations are needed to clarify this issue.

Although the meta-analysis showed a clear benefit of financial incentives, there was considerable clinical variation among the included studies. The control conditions were not uniform, ranging from counselling alone to counselling combined with nicotine replacement therapy, and in some cases included show-up fees. Likewise, the incentives differed widely in their form, mode of delivery (cash, vouchers, or smartphone-based rewards), and monetary value. Follow-up periods and definitions of smoking cessation also varied across trials. Taken together, these differences limit direct comparisons between studies and indicate that the pooled effect should be viewed as reflecting an overall favourable pattern rather than a precise or universally applicable estimate of effect.

The level of addiction was assessed in only two studies [21,25] and the results suggested the level to be high. The readiness to quit the habit was also assessed in only two studies [22,24] and the results suggested that the majority of the participants were ready to quit.

Studies evaluating the postpartum quit rate have indicated a quick return to smoking, indicating the need for ongoing incentive payments to be used in the postpartum period to avoid relapse. However, postpartum smoking outcomes were reported in a variable manner and could not be combined in a quantitative synthesis. Although several studies observed a reduction in abstinence after childbirth, differences in follow-up time points and outcome definitions prevented formal pooling of these data. This underscores the need for more consistent postpartum outcome measures and longer-term follow-up in future research. Also, greater efforts are required to maintain prenatal and postpartum abstinence levels through planning for maintenance in incentive-based treatments, since exposure to secondhand smoke after delivery can have negative health effects on the baby (such as respiratory infections, exacerbation of asthma, and sudden infant death syndrome). [27]

Prenatal and postnatal incentives for pregnant smokers were discussed in a Cochrane review [28] on smoking cessation incentives. There were nine randomised trials with varied populations and interventions (cash, vouchers, gift cards, social support) included. Financial incentives demonstrated a substantial improvement over no incentives control (relative risk 2.38, 95% confidence interval 1.54 to 3.69, n = 2273), without variations between the prenatal and postnatal interventions. A total of 332 people took part in another systematic review [12] on financial incentives for quitting smoking during pregnancy. There was a 2.58 relative risk of quitting based on the combined effect size (95% confidence interval 1.63 to 4.07).

When incentives were given, the smoking status of those declaring abstinence was verified using biochemical testing. This procedure is the gold standard for effective trial design in studies on smoking cessation in this process. [29] Additionally, as deceit may be a legitimate criticism of incentive-based studies, it may be especially crucial that those who quit in an experiment based on rewards are demonstrated to be truly abstinent at the evaluation points.

Only two research measured the amounts of serum cotinine and breath carbon monoxide together. Serum cotinine may have been more sensitive in identifying temporally remote smoking than breath carbon monoxide, which has a comparatively short half-life [30, 31]. Hence, using both biochemical measures together may improve the accuracy of smoking status verification and reduce the likelihood of misclassification or misreporting.

Although the results of this review seem promising, it is crucial to note that there can be significant obstacles to integrating incentives into standard care or mainstream services. The general public's perception of incentives is generally unfavorable [32], with incentives being regarded as "rewarding" behavior modification for a "habit" that is thought to be self-inflicted (smoking). This might reduce the amount that trial findings can influence modifications to procedures and policies. The limitation of resources is another difficulty. Funders (like the NHS or local government in the UK) that provide funding for smoking cessation services must prioritize these programs over alternative methods of quitting smoking in order for them to be implemented in the real world. The possible negative effects of incentive programs need to be further considered. Those who relapse to smoking and do not receive a financial incentive may stop trying to quit in the future. Future trials should monitor this possible harm.

LIMITATIONS

Despite the rigorous approach used, there are certain inevitable limitations to this review. Four studies had an unknown risk of bias and one study had a high risk of bias, which may have compromised the studies' overall quality. In one study nicotine replacement therapy was offered in addition to financial incentives which could have acted as a confounding factor. The level of addiction and readiness to quit the habit were not measured in the majority of the studies. The patients' varying degrees of addiction and readiness to quit could have had an impact on the studies' findings. Two studies used smartphone apps to provide remote financial incentives. It's possible that remote incentives unintentionally catered to a more privileged and limited demographic than planned.

Despite the low level of statistical heterogeneity, there was considerable clinical heterogeneity among the included studies. Trials differed in their control interventions, the type and value of incentives offered, follow-up durations, and definitions of smoking cessation outcomes. These variations may limit the generalisability of the pooled effect estimates. In addition, postpartum outcomes were reported descriptively rather than analysed quantitatively, which restricts conclusions about the long-term effectiveness of financial incentives. These issues should be taken into account when interpreting the results.

FUTURE RECOMMENDATIONS

Future trials should incorporate pregnant smokers, medical experts, and policy makers in their conception, planning, recruiting, and design in order to evaluate the acceptability and cost-effectiveness of this treatment strategy. The necessity of taking into account the cultural setting in which the study is being done is highlighted by the disparate responses to financial incentives in different countries and even geographical areas. Regardless of the mother's smoking status, second-hand smoke exposure during pregnancy is linked to a higher risk of smoking-related health problems. Future

research should therefore evaluate the effectiveness of monetary incentives in assisting pregnant smokers' spouses in giving up their smoking. Future research and treatment that makes use of online recruitment strategies will need to figure out how to reach the largest possible portion of this population as well as how to make participation easier for women who do not have access to technology, such as by leading them in the direction of community resources that provide free computer and Internet access [33] and/or programs that give away free mobile phones to low-income people [34]. It's also important to compare the various incentive programs to see which one helps people quit smoking the most. Assessment of the level of addiction and readiness to quit the habit is necessary because these variables influence the study's outcome.

CONCLUSION

This systematic review and meta-analysis indicate that adding financial incentives to standard smoking cessation counselling is associated with higher quit rates among pregnant women compared with counselling alone. However, these findings should be interpreted with caution because of the considerable clinical heterogeneity across the included studies, particularly with respect to control interventions, the type and size of incentives, outcome definitions, and follow-up periods.

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