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Clinical interventions to reduce secondhand smoke exposure among pregnant women: a systematic review

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Abstract

Objective—To conduct a systematic review of clinical interventions to reduce secondhand smoke (SHS) exposure among non-smoking pregnant women.

Data sources—We searched 16 databases for publications from 1990 to January 2013, with no language restrictions.

Study selection—Papers were included if they met the following criteria: (1) the study population included non-smoking pregnant women exposed to SHS, (2) the clinical interventions were intended to reduce SHS exposure at home, (3) the study included a control group and (4) outcomes included either reduced SHS exposure of non-smoking pregnant women at home or quit rates among smoking partners during the pregnancy of the woman.

Data extraction—Two coders independently reviewed each abstract or full text to identify eligible papers. Two abstractors independently coded papers based on US Preventive Services Task Force criteria for study quality (good, fair, poor), and studies without biochemically-verified outcome measures were considered poor quality.

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Contributors: VTT led the review process and manuscript preparation. VTT, IVR, PMD and LJE provided input on the search strategy, and WT conducted the search of the bibliographic databases. VTT, PMD, IVR and SMK reviewed abstracts for eligibility, and VTT and PMD abstracted the data and assessed quality of the papers. VTT, PMD and WT drafted sections of the manuscript, and all coauthors provided critical input and review of the entire manuscript.

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Data synthesis—From 4670 papers, we identified five studies that met our inclusion criteria: four focused on reducing SHS exposure among non-smoking pregnant women, and one focused on providing cessation support for smoking partners of pregnant women. All were randomised controlled trials, and all reported positive findings. Three studies were judged poor quality because outcome measures were not biochemically-verified, and two were considered fair quality.

Conclusions—Clinical interventions delivered in prenatal care settings appear to reduce SHS exposure, but study weaknesses limit our ability to draw firm conclusions. More rigorous studies, using biochemical validation, are needed to identify strategies for reducing SHS exposure in pregnant women.

INTRODUCTION

Though maternal smoking has been established as a preventable and modifiable risk factor for infant morbidity and mortality,[1] there is growing evidence that secondhand smoke (SHS) exposure during pregnancy may also have negative consequences for pregnancy and infant outcomes. For example, infants born to women exposed to SHS during pregnancy are more likely to be low birth weight (pooled OR=1.2, 95% CI 1.1 to 1.3) compared with infants not exposed to SHS.[2] A more recent systematic review found an adjusted relative risk (RR) about the same magnitude as previous reviews (RR=1.16, 95% CI 0.99 to 1.36).[3] Across prospective and retrospective studies, mean birth weights are estimated to be about 33–40 g less among women exposed to SHS.[4] One study based on a sensitive assay for cotinine showed a birth-weight decrement of 27.2 g (95% CI 0.6 to 53.7) per unit change in log cotinine, which represented a decrement of about 100 g between the highest and lowest cotinine quintiles.[5] In addition, SHS exposure during pregnancy has been associated with a slight increased risk of stillbirth, preterm delivery and congenital anomalies, although results have been inconsistent.[346]

Globally, more than a third of all women are estimated to be regularly exposed to SHS.[7] Though individuals may be exposed in a number of locations, most SHS exposure among reproductive-aged women in low- and middle-income countries occurs at home where women spend most of their time and a low proportion of women work outside of their home; estimates of SHS exposure at home ranged from 17.8% in Mexico to 72.3% in Vietnam.[8] However, there are limited data on the extent to which women are exposed to SHS during pregnancy, particularly in low- and middle-income countries. An analysis of nationally representative data from 42 low- and middle-income countries during 2003–2009 found the prevalence of self-reported SHS exposure during pregnancy ranged from 9.3% in the Dominican Republic to 82.9% in Timor-Leste.[9] Surveys conducted in antenatal care settings in nine developing countries found that 17.1% (Democratic Republic of the Congo) to 91.6% (Pakistan) of pregnant women reported that smoking was permitted in their home, and 8.3% (Democratic Republic of the Congo) to 49.9% (Pakistan) reported frequent exposure to SHS indoors.[10] From this study, which only included countries in three WHO regions, the highest SHS exposure among pregnant women were in Latin American and Asian countries, where smoking prevalence is high among men. Factors associated with SHS exposure among pregnant women at home included smokers living in the household and low level of knowledge of the harms of SHS.[1011]

It is estimated that at least 80% of pregnant women receive antenatal care at least once during their pregnancy;[9] these visits provide an opportunity to screen and counsel pregnant women regarding SHS. Previous systematic reviews of clinical interventions on reducing SHS have focused primarily on reducing infants' or children's exposure with the target of the intervention being parents or caregivers.[12–14] In a review by Baxter *et al*[12] of prenatal and postpartum interventions in published studies between 1990 and 2009, only one study[15] of 17 reviewed tested any type of intervention to reduce SHS exposure during pregnancy; however, the authors excluded it from indepth analysis because the study did not report on changes in SHS exposure. To our knowledge, there are no previous systematic reviews that included studies reported in all languages and focused on clinical interventions to reduce SHS exposure during pregnancy and among non-smoking women.

The purpose of this study was to conduct a systematic review of clinical interventions to reduce SHS exposure among nonsmoking pregnant women. Clinical interventions include both psychosocial and pharmaceutical interventions that are delivered in antenatal healthcare setting by any type of provider. Commissioned as part of the development of WHO Recommendations for the Prevention and Management of Tobacco Use and Secondhand Smoke Exposure in Pregnancy,[16] this evidence review addressed one of six areas that was the focus of the guidelines. This current review builds on the previous Baxter *et al*[12] review, updates the study period to January 2013, refines the search strategy to the pregnancy period and expands the databases searched to include studies reported in all languages, including from low- and middle-income countries where there may be research in this area.

METHODS

Search strategy

The PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses was used to guide this review. We developed a search strategy to identify relevant studies with the assistance of a reference librarian. The strategy combined terms related to smoking (eg, tobacco smoke pollution, environmental tobacco smoke, passive smoke, secondhand smoke, involuntary smoke, smokefree) with terms related to pregnant women and their families (eg, pregnant women, pregnancy, mother, maternal, fetus, infant, newborn, prenatal, antenatal). The search strategy was kept broad to retrieve as many relevant articles as possible (see online supplementary appendix 1 for the MEDLINE search strategy).

Databases were searched for items published from 1990 to August 2012. A later series of searches updated the retrieval through January 2013. There were no language restrictions.

Systematic searches were conducted of the following databases: MEDLINE (Ovid), MEDLINE In-process & Other Non-Indexed Citations (Ovid), Embase (Ovid), PsycInfo (Ovid), Global Health (Ovid), CINAHL (EbscoHost), ASSIA (Applied Social Sciences Index and Abstracts) (ProQuest), Web of Knowledge and Cochrane Library. We searched and reviewed items from WHO Global Health Library, WHO International Clinical Trials Registry, Clinicaltrials.gov, Trip Database, Scirus and Google Scholar. We also reviewed the reference lists of selected articles retrieved by the searches to identify additional articles of interest.

Review process

An article was considered for inclusion in the literature review if it satisfied the Population, Intervention, Comparison, Outcome (PICO) criteria: (1) population: non-smoking pregnant women exposed to SHS, (2) intervention: clinical interventions to reduce exposure to SHS at home, (3) comparison: no intervention to reduce exposure to SHS at home and (4) outcome: either reduced exposure of non-smoking pregnant women to SHS at home during pregnancy or quit rates among smoking partners during the pregnancy of the woman. The PICO criteria were developed a priori based on consultation from a WHO guidelines development group and external stakeholders at two international meetings of tobacco control and reproductive health experts. Clinical interventions, again, included both psychosocial and pharmaceutical interventions delivered in an antenatal care setting. Studies were included if the comparison was reported as standard of care which may or may not include some advice about SHS, and information on whether the comparison group included SHS education or advice was noted in the review. All study designs were considered in this review if they met the eligibility criteria. If studies reported birth outcomes, we included that information in this report, but did not exclude studies that do not report on birth outcomes. Studies were excluded if the intervention was not focused on reducing SHS exposure among non-smoking women during pregnancy or if the outcomes were not measured during or at the end of pregnancy.

A total of six reviewers assisted in screening abstracts, but for each abstract, at least two individuals independently screened titles and abstracts to identify articles eligible for full-text review. English language abstracts were screened, but we did not restrict language of full papers. Discrepancies in selection were resolved via discussion with first and second authors of this review, and a final list of eligible studies was decided by consensus. Next, full articles were read by two reviewers to confirm inclusion of each article for the final study. One article was published in Chinese, and translation assistance was provided by a scientific collaborator who had expertise in tobacco control. Relevant information was abstracted from each study and synthesised in narrative form.

Study quality

Two reviewers assessed the quality of each study by adapting a published set of criteria, based on study design and internal validity, developed by the US Preventive Services Task Force.[17] Studies were given a grade for research design (I=randomised controlled trials (RCT); II-1=well-designed controlled trial without randomisation; and II-2=well-designed cohort or case-control study) and a separate grade for internal validity (good, fair or poor). For RCTs, internal validity was based on the following six criteria: adequate randomisation, low attrition and high adherence, low differential or total loss to follow-up, clear definition of intervention, high reliability and validity of exposure and outcome measures, and inclusion of an intent-to-treat analysis. ‘Good’ studies met ≥5 of the six criteria, and ‘fair’ studies met <5 of the criteria. In addition, given the high risk of bias of self-reported measures in cessation trials among pregnant women[18,19] and the low reliability of self-reported SHS exposure,[20] studies that used self-reported measures of SHS or partner quitting were automatically considered of ‘poor’ quality. A meta-analysis was not conducted because of the limited number of studies that met our inclusion criteria and the diversity of SHS

exposure outcomes the studies assessed. Only one study assessed quitting among partners of pregnant women.

RESULTS

The search generated 5846 citations, and after removing duplicate citations, 4670 abstracts were reviewed for eligibility based on the PICO criteria (figure 1). Two trial protocols met the PICO criteria, but the published study results were not found in the search databases and thus were not assessed in this review.[21] 22 Of the abstracts screened, 23 full papers were reviewed. Five met the inclusion criteria and were the primary study papers.[23–27] Thirteen papers were publications of the five studies included in our review (eg, formative research or addressed other research questions using the same study data but not the focus of this review),[28–40] and these studies were reviewed by study authors to locate relevant data for this review. Of the remaining papers, studies were excluded if they did not report SHS as primary outcome,[154142] if target population did not include pregnant non-smokers[43] or if there was no comparison group.[44]

Settings and samples

Table 1 provides summary characteristics of the five included studies, and online supplementary table S1 provides detailed information abstracted from the studies. Four interventions focused on reducing SHS exposure at home among nonsmoking pregnant women, and one intervention focused on promoting quitting among partners of pregnant women, including both smokers and non-smokers. Study locations were Washington, DC, USA; Isfahan, Iran; Guangzhou and Sichuan, China (two studies); and Brisbane, Australia. All five were RCTs (one stratified RCT), and sample sizes ranged from 91 to 758. In all five studies, pregnant women or their husbands were recruited during antenatal care. The US study recruited African American women who reported SHS exposure,[23] and the studies in Iran and China recruited married and literate women whose husbands were smokers.[242527] In Australia, after having received permission from the pregnant women during prenatal care, male partners who smoked ≥10 cigarettes a day were recruited.[26]

Types of interventions

In summary, four of the studies involved psychosocial interventions with various forms of counselling interventions delivered to pregnant women within the antenatal care setting, and the fifth study involved psychosocial intervention plus medication to partners of pregnant women. Among these studies, all provided information on the harms of SHS and made follow-up contact with participants. One intervention included negotiation skills for pregnant women,[23] and two encouraged implementing smoke-free home rules.[2327] All interventions promoted partners or household members to quit smoking; however, only one provided direct assistance to partners[26] and one provided educational materials to pregnant women targeted for household members.[24] One was high intensity,[23] three were medium[242627] and one was low.[25] Interventions are described in more detail.

In the US study, the intervention was delivered over eight sessions during prenatal care and two sessions during postpartum visits, each session lasting an average of 30–45 min.[23]

Several publications were found based on this single trial, but one paper (included in this review) analysed a subsample of non-smoking pregnant women who self-reported SHS exposure. Cognitive behavioural strategies to eliminate or minimise exposure to SHS were employed by trained counsellors, including role play, skills practice, building negotiation skills with partners and household members who smoked, education about the risk of SHS during pregnancy, and encouragement of household smoking bans.

In Guangzhou, China, an obstetrician gave brief advice on health risks of exposure to tobacco smoke (2–3 min in duration) to pregnant women who reported SHS exposure in the home from their husbands.[25] The advice included a description of health risks related to SHS exposure and the importance of avoiding exposure. Women were also encouraged to help their husbands stop smoking. In addition, women received an educational booklet describing the risks of SHS exposure and strategies for helping their husbands to stop smoking. In subsequent prenatal visits, women received brief reminders (1.5 min on average) of the importance of avoiding SHS and were encouraged to help their husbands to quit smoking.

In Sichuan, China, study participants in the intervention group were provided with educational materials about the harms of SHS, the importance of establishing smoke-free families and ways to avoid SHS exposure.[27] Women participated in seminars, role playing, watching videos and entered in contests to test their understanding of the self-education materials. In addition, they were provided counselling by an obstetrician, followed by monthly phone calls, and were provided access to a telephone hotline for support.

In Isfahan, Iran, trained midwives delivered one-on-one education on SHS risks to women for 15–20 min at the first prenatal visit and for 5–10 min at the second prenatal visit.[24] Women were also given educational materials which provided information on the health risks of SHS for the fetus, a picture of a low birthweight infant and how the toxic substances from SHS can cross the placenta to the fetus, and a resource booklet to use at home which used simple terms and pictures to communicate knowledge.

In Australia, both counselling and use of a nicotine patch were used to help partners of pregnant women to quit smoking; thus, the outcome of this study was not measured in the pregnant women.[26] The intervention included one partner counselling session with a general practitioner by telephone, which included a history and assessment of smoking status and dependence, an explanation of the use of the nicotine patch and recommended a 1-week supply of patches plus a prescription for an additional 3-week supply. After the counselling session, the 1-week supply of nicotine patches and intervention materials were mailed to partners: (1) an 18 min video with a nationally-known athlete becoming a father and SHS risks for the newborn; (2) information on how to use the nicotine patch; (3) a booklet on quitting; and (4) a letter written for the participant’s general practitioner explaining the study. After 1 week, a newsletter was sent on tips on quitting and motivational anecdotes.

Findings

Results from all five studies showed positive findings based on study-defined outcome measures. However, it should be noted that the outcomes were measured in the partners of

pregnant women in one study, and of the four studies that measured the outcomes among pregnant women, there were variations in how reduction in SHS exposure were defined and the length of time the outcomes were measured. Furthermore, three of the five studies were based on self-report of SHS exposure and were not biochemically-validated, and thus were judged as poor quality. A meta-analysis was not performed because of the diversity of SHS outcomes; SHS outcomes included women's report of the quit status of the husbands, report of cigarettes the husbands smoked near the women, and exposure to cigarette smoking in home, same room, or car with a smoker.

Biochemically-verified outcome measures

Of the two studies that included biochemical validation, one tested nicotine in maternal hair samples[27] and the other tested for carbon monoxide (CO) in expired air of a subsample of partners who reported quitting.[26] However, both studies had additional risks of bias that should be considered when interpreting the outcomes measures.

In the Sichuan, China, study, the provision of educational materials about SHS and of counselling by an obstetrician was associated with decreased mean hair nicotine concentration in the intervention group compared with the control group: 0.3 log micro g/g at follow-up compared with 0.5 at baseline; and for control: 0.5 log micro g/g at follow-up compared with 0.4 at baseline.[27] This difference was reported as statistically significant at $p<0.05$. The outcome was measured approximately 1 month prior to delivery.

In the Australian study, 48 out of 291 (16.5%) men in the intervention group reported 6-month quitting compared with 25 out of 270 (9.3%) men in the control group ($p=0.011$, OR=0.52, 95% CI 0.31 to 0.86).[26] Of 24 self-reported quitters in the intervention group with CO testing, 23 (95.8%) were verified as having quit; of 21 self-reported quitters in control group, 14 (66.7%) were verified as having quit; seven refused CO testing and were assumed to be continuing smokers. Quit rate of partners of non-smoking pregnant women was not provided; however, the authors note that quit rates of the partners did not vary by pregnant women's smoking status.

Self-reported outcome measures

There were three studies that used self-reported SHS outcomes, and the definition varied by study. In the US study, which used the most intensive of all included interventions (counselling addressed multiple risk factors and lasted about 30–45 min), SHS exposure was defined from women's report of exposure to cigarette smoking in the home, same room or car with a smoker during a typical week, and this outcome was measured during the second or third trimester of pregnancy. Women in the intervention group were less likely to self-report SHS exposure than women in the control group (OR 0.57, 95% CI 0.38 to 0.84).[23] No differences were found in low birth weight, neonatal hospitalisation or preterm delivery <37 weeks between infants of mothers in the intervention and control groups ($p>0.05$). They found only differences in preterm delivery at <34 weeks gestation were reported between treatment arms; however, pregnancy outcome data were not available for all participants. In a later published study, when missing pregnancy outcomes were imputed, no difference was detected in any pregnancy outcomes between treatment arms.[31]

In the briefest of interventions, conducted in Guangzhou, China, women in the intervention group were more likely than those in the control group to report their husbands not smoking in the past 7 days (8.4% vs 4.8%, p=0.04); however, no difference was found in their husbands not smoking in the last 30 days (6.1% vs 4.2%, p=0.26).[25] Women in the intervention group reported that their husbands were more likely to have attempted to quit (30.0% vs 22.2%, p=0.02) and to have decreased the number of cigarettes smoked daily (39.7% vs 17.7%, p<0.0001) compared with women in the control group.

In the study conducted in Isfahan, Iran, self-reported weekly SHS exposure was measured by the mean number of cigarettes smoked per week by the husband at home and near the pregnant woman. Self-reported weekly SHS exposure was statistically lower in the intervention group compared with the control group at third, fourth and fifth prenatal care sessions compared with the initial session, p<0.001 (eg, at fifth visit, 12.3 vs 25.4 weekly mean number of cigarettes the husband smoked near the pregnant woman).[24]

Risks of bias

The strengths of the research were that all studies had random assignment to intervention and control groups, and three of the five studies used an intent-to-treat analysis (it is assumed that all study participants lost to follow-up continued to be exposed to SHS or partner continued to smoke). Three of the five studies had outcome measures based only on self-report and so were judged to be of poor quality.[232425]

The remaining two studies were considered to be of fair quality: the Australian study and the Sichuan, China, study.[2627] The Australian study did not report data on adherence to intervention and lacked sufficient detail on the randomisation process, and there were significant differences in baseline characteristics between intervention and control arms. Additionally, CO testing was only completed on a subsample of quitters, and CO is sensitive for only recent smoking within the past day.[45] Though the biochemical verification data suggest that quitters in the control group were more likely to incorrectly report their quit status, it was unclear how the subsample was identified and whether potential biases exist. The Yang *et al* study also did not report data on adherence to intervention and did not conduct an intention-to-treat analysis; loss to follow-up was approximately 14%. Nicotine accumulation in hair is less affected by daily variability of exposure, and 1 cm of hair near the scalp can indicate exposure in the past month; however, it is unknown what effect hair treatment, hair colour and growth rate has on nicotine levels in hair.[46]

DISCUSSION

This is the first systematic review to consider the efficacy of clinical interventions to reduce SHS exposure of non-smoking women during pregnancy. Overall, the literature is limited in the number and quality of studies that have addressed the intervention of interest. We found five studies conducted in four different countries, with sample sizes ranging from 91 to 758 individuals. In two study sites (China and Iran), the smoking prevalence among men is much higher than among women. Our review suggests that clinical interventions delivered in a prenatal care setting may help to reduce SHS exposure during pregnancy, but because self-reported tobacco exposure during pregnancy may be unreliable, these results need to be

replicated with biochemically-validated outcomes. Only one study directly targeted partners who smoked, and results suggest that counselling and providing nicotine patches increased quitting in the partners/husbands of pregnant women (OR=0.52, 95% CI 0.31 to 0.86), though only a subsample of quitters was biochemically-validated.[26]

As noted earlier, more trials are needed that include biochemically-validated reduced SHS exposure as self-reported measures, though more acceptable to study participants and convenient, are of limited utility in determining efficacy of interventions.[20] A review of self-reported measures found that for pregnant women, hours of women's SHS at home and cigarettes smoked per day at home were not reliable measures of SHS exposure when compared with cotinine level from cord blood.[20] Outcomes could be validated using biomarkers specific to SHS exposure including nicotine (ie, nicotine in hair) and its metabolites, of which cotinine in blood, urine and saliva is the most frequently used,[47] or through environmental monitoring of particulate matter and airborne nicotine particles.[48] For studies in settings where active maternal smoking is prevalent, it may be necessary to distinguish active smokers and non-smoking pregnant women exposed to SHS using these biochemical markers. Cotinine cut-off points for active smoking in non-pregnant populations vary depending on a country's prevalence of SHS exposure and active smoking, patterns of use in active smokers (eg, daily vs non-daily) as well as variations of nicotine metabolism by race/ethnicity.[47] For example, the preferred cut-off point for active smoking is 12 ng/mL in the UK, where SHS exposure is still relatively high, and 3 ng/mL in the USA, where SHS exposure is reduced.[47] In addition, pregnant women have higher metabolism of nicotine and higher cotinine clearance rates; therefore, lower cut-off points may be appropriate.[49] One study conducted in Japan found that the optimal serum cotinine cut-off point for SHS exposure among pregnant women was 0.21 ng/mL.[50] Another biomarker for SHS exposure is hair nicotine, which can indicate longer-term exposure, up to the last 30 days, and is less affected by daily variability of exposure and differences in metabolism and elimination of nicotine.[47] Hair cotinine cut-off point value for SHS exposure in pregnant women (0.2 ng/mg) was determined using data from the USA, Canada and France.[51] Though long-term use biomarker testing for exposures may be cost-prohibitive or impractical in countries with low resources, valid and reliable outcome measures are of utmost importance in studies to establish intervention efficacy, particularly among pregnant women who may be compelled to report positive behaviour changes. Less expensive tests or proxies that have high validity for SHS exposure or for quitting can be explored.

In some cultures, extended families or multi-generational families live in the same home, so interventions may also be needed to address all smokers in the home, not just partners or husbands. Barriers to women establishing smoke-free homes include low self-efficacy and shame in asking guests not to smoke.[1530] In addition, there may be a lack of understanding of the harms of SHS. One study conducted in Australia found women's partners thought SHS caused little or no harm to the pregnant woman and her fetus.[52] In some settings and cultures, gender roles and empowerment may also be a barrier; thus, interventions may also need to address empowerment and negotiation skills.[15] Thus, qualitative studies are needed to better understand barriers to eliminating SHS exposure in pregnant women. Furthermore, our systematic review focused on exposure and quit measures. Negative or unintended

consequences of these interventions on the women and her family were not reported in these trials and may need further study.

Only two of the studies included in our review provided any counselling about encouraging smoke-free home rules and designating a smoking area, in addition to encouraging partners or household members about quitting or avoiding SHS.[2327] There is growing evidence that establishing smoke-free home rules is effective in reducing SHS exposure and increasing smoking cessation.[5354] One US study found that adoptions of home rules promoted immediate cessation among household members, and among those who do not quit right away, their likelihood of quitting in the next year was also increased.[54] Population-based studies have also found smoke-free home rules can support cessation efforts and were significant predictors of quitting.[55] Thus, interventions to reduce SHS exposure may be more successful if they employ strategies to promote adoption of smoke-free home rules in concert with providing advice and cessation support to household smokers.

Currently, many high-income countries have national treatment guidelines for tobacco cessation interventions for pregnant women; few low- or middle-income countries have such guidelines; and no country has clinical recommendations for eliminating SHS exposure during pregnancy.[56] WHO developed the first-ever guidelines for the prevention and management of tobacco use and SHS exposure during pregnancy.[16] They recommend that healthcare providers ask all pregnant women about exposure to SHS as early as possible in the pregnancy, and at every antenatal care visit. They also recommend that healthcare providers give pregnant women, their partners, and other household members advice and information about the risks to pregnant women from SHS exposure, and wherever possible, to provide cessation support to partners and other household members. The guidelines also recommend adoption of smoke-free places and strategies to eliminate SHS in homes.

WHO also recommends countries implement strong tobacco control policies (eg, public and worksite smoking bans) as outlined by WHO Framework Convention on Tobacco Control (FCTC).[57] Public smoking bans have been shown to increase the percentages of homes that are smokefree,[58] but they have also been effective in reducing SHS exposure among pregnant women.[5960] The FCTC provides guidance on the underlying rationale for protecting women and their offspring from tobacco and describes mechanisms to successfully decrease exposure.

In conclusion, there are few studies that have assessed the efficacy of clinical interventions to reduce SHS exposure among non-smoking pregnant women. Our review included studies of varying intensity levels of psychosocial interventions, but limited information does not allow us to identify one intervention as being more effective than the others. However, there were common features across the four interventions targeting pregnant women. Three studies used clinic staff (ie, physicians, midwives) to deliver the advice while the US study used a trained counsellor. All included at minimum one follow-up reminder at subsequent prenatal care visits. Additional studies are needed to test interventions to reduce SHS during pregnancy, including ones that might promote creating smoke-free homes, and this is particularly important in countries where the prevalence of smoking is very high among men and low among women. Until additional evidence becomes available, providers should, at a

minimum, offer pregnant women information about the risks of SHS exposure from all forms of smoked tobacco as well as strategies to reduce SHS in the home and encourage household members to quit smoking.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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What this study adds

- Secondhand smoke (SHS) exposure during pregnancy increases the risk of delivering a low birthweight infant.
- In a systematic review of publications from 1990 to January 2013, we found five studies that have assessed the efficacy of clinical interventions to reduce SHS exposure among non-smoking pregnant women.
- This review found that clinical interventions delivered in a prenatal care setting appear to reduce SHS exposure during pregnancy, but study weaknesses limit our ability to draw firm conclusions. New more rigorous studies are needed to identify strategies to reduce SHS exposure in pregnant women.
- As recommended by WHO, providers should, at a minimum, advise all pregnant women to avoid SHS exposure from all forms of smoked tobacco and encourage household members to quit smoking.

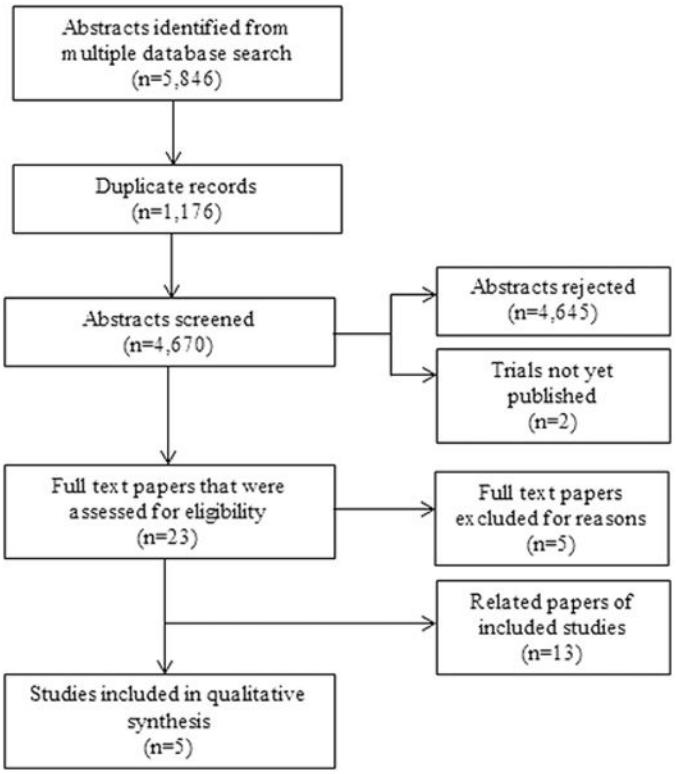

Figure 1.
Flow diagram of included and excluded studies.

Table 1

Summary characteristics of included studies

Study	Country	Sample size	Target population	Main intervention strategy	Comparison	Outcome measure	Biochemical-verification	Effect	Quality*
Stanton 2004	Australia	561	Partners of non-smoking and smoking pregnant women	NRT and counselling by physician	Pamphlet with cessation options	Quits at 6 month of partner	Yes, but only a subsample was confirmed with carbon monoxide	Significant effect	I-fair
Loke 2005	China	758	Pregnant non-smokers	Brief advice and reminders by physician	Standard prenatal care	7- and 30-day abstinence of husband reported by the pregnant women	No	Significant effect on 7-day; no effect on 30-day	I-poor
El-Mohandes 2008	USA	520	Pregnant non-smokers	Counselling for multiple risks by counsellor	Standard prenatal care	Change in SHS exposure of pregnant women in second and third trimesters	No	Significant effect	I-poor
Yang 2010	China	186	Pregnant non-smokers	Brief counselling and education by physicians	Standard prenatal care	Hair nicotine levels of pregnant women	Yes	Significant effect	I-fair
Kazemi 2012	Iran	91	Pregnant non-smokers	Counselling by trained midwives	Standard prenatal care, education on prevention of infectious disease	Weekly SHS exposure at home of pregnant women	No	Significant effect for third, fourth, fifth prenatal visits compared with first visit	I-poor

* Based on US Preventative Task Force criteria for research design (I=randomised controlled trials (RCT); II-1=well-designed controlled trial without randomisation; and II-2=well-designed cohort or case-control study) and a separate grade for internal validity (good, fair or poor). For RCTs, internal validity was based on the six following criteria: adequate randomisation, low attrition and high adherence, low differential or total loss to follow-up, clear definition of intervention, high reliability and validity of exposure and outcome measures, and an intent-to-treat analysis. 'Good' studies met ≥5 of the six criteria, 'fair' studies met <5 of the criteria, but did not have a fatal flaw (ie, no biochemical verification) and 'poor' studies contained a fatal flaw.

NRT, nicotine replacement therapy; SHS, secondhand smoke.