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What components of smoking cessation care during pregnancy are implemented by health providers? a systematic review and meta-analysis

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Abstract

Background Pregnancy is an opportunity for health providers (HPs) to support women to stop smoking.

Objectives Identify the pooled prevalence for HP in providing various components of smoking cessation care (SCC) to women who smoke during pregnancy.

Design A systematic review synthesising original articles that reported on 1) prevalence of HPs performing the 5As ('Ask', 'Advise', 'Assess', 'Assist', 'Arrange'), prescribing nicotine replacement therapy (NRT), and other SCC, and 2) factors associated with SCC practices.

Data Sources MEDLINE, EMBASE, CINAHL and PsycINFO databases searched using "smoking", "pregnancy" and "HP practices".

Eligibility criteria for selecting studies Studies included any design except interventions (self-report, audit, observed consultations, women's reports), in English, with no date restriction, up to June 2017.

Participants Health providers of any profession

Data extraction, appraisal and analysis Data were extracted, then appraised with the Hawker tool. Meta-analyses pooled percentages for performing each of the 5As and prescribing NRT, using e.g., 'often/always' and 'always/all'. Meta-regressions were performed of 5As for 'often/always'.

Results Of 3933 papers, 54 were included (*n* =29,225 participants): 33 for meta-analysis. HPs included general practitioners, obstetricians, midwives and others from 10 countries. Pooled percentages of studies reporting practices 'often/always' were: 'Ask' (*n*=9) 91.6%

(95%CI:88.2,95); 'Advise' (*n*=7) 90% (CI:72.5,99.3), 'Assess' (*n*=3) 79.2% (CI:76.5,81.8), 'Assist (cessation support)' (*n*=5) 59.1% (CI:56, 62.2), 'Arrange (referral)' (*n*=6) 33.3% (CI:20.4,46.2), and 'prescribing NRT' (n=6) 25.4% (CI:12.8,38). Heterogeneity (I^2) was 95.9%-99.1%. Meta-regressions for 'Arrange' were significant for year (p=0.013) and country (p=0.037).

Conclusions HPs 'Ask', 'Advise' and 'Assess' most pregnant women about smoking. 'Assist', 'Arrange' and 'prescribing NRT' are reported at lower rates: strategies to improve these should be considered. Strength of this review is the inclusion of papers from 10 countries, and the detailed analysis of study measures from HP and women's viewpoints, limited by few studies in each category, and high heterogeneity.

Registration PROSPERO 2015:CRD42015029989.

Strengths and limitations of this study

- To our knowledge, this is the first systematic review to comprehensively analyse empirical data on health providers implementation of the 5As by analysing like measures for SCC, and the only review, as far as we are aware, to perform a meta-analysis and meta-regression.
- Fifty four studies were included from 7 high-income and three low to middle income countries and includes health providers from disciplines of medicine, nursing, and allied health.
- The review was limited by not being able to determine the cause for the high heterogeneity in the meta-analyses by our meta-regression, except for 'Arrange referral-often/always' which was related to year, and country: this suggests a cautious interpretation.

- The quality rating revealed aspects of some papers were poor; findings from these studies may be less reliable.
- Our review aids in determining which components of SCC are unreliably implemented to guide strategies to improve SCC in pregnancy.

Keywords: smoking, health care providers, smoking cessation, maternal health, pregnancy

Word count: 4724

Introduction

Smoking during pregnancy carries high risks for mother and child, including obstetric complications for the mother,[1] and for the baby, premature birth, growth restriction, low birth weight, still-birth, and congenital defects.[1] Longer-term effects on the child include respiratory illnesses, learning and behavioral problems, childhood cancer, and increased risks of chronic diseases,[1] and of taking up smoking in adolescence.[2]

Smoking during pregnancy remains a prevalent behaviour in many countries, with estimated smoking prevalence rates ranging from 0.2% to 38.4%.[3] Pregnancy is a time when women are more likely to be motivated to stop smoking.[4] However, disadvantaged women, including women from minority and Indigenous populations where there is a high prevalence of community smoking, also smoke at higher rates and are less likely to try to stop smoking, or succeed.[5, 6] Also, less likely to stop smoking are women who are: of low socio-economic status,[5] multi-parous,[5] adolescents,[7] partnered by smokers,[5] and those experiencing: alcohol or substance use,[7] depression,[8] life stressors,[9,10] or intimate partner violence.[11] Women frequently reduce tobacco consumption when discovering they are pregnant,[10,12] indicating a consciousness about the risks, but may be less likely to abstain.[13] Pregnant women report a lack of support for smoking cessation, and that health providers (HP) consider cutting down to be acceptable.[14,15]

HPs in primary care have a critical role to offer advice and support women to stop smoking during pregnancy.[16] Ideally smoking cessation care (SCC) includes counselling and pharmacotherapy – most successful when combined.[16,17] In pregnancy, the effective use of pharmacotherapy is less certain, and clinical guidelines vary across and within different

countries.[16] In pregnancy, only nicotine replacement therapy (NRT) is recommended, but not consistently advised for use in pregnancy in all countries,[16,18] for example NRT is not advised in the USA for use in pregnancy,[19] but it is more routinely prescribed in the UK.[20] Clinical guidelines in the UK, Australia, New Zealand and Canada recommend that a woman should initially endeavour to quit without medication, but if she cannot, NRT can be prescribed.[16 21-24]

The 5As ('Ask (about smoking)', 'Advise (to quit)', 'Assess (motivation and/or dependence)', 'Assist (with cessation)', and 'Arrange (follow-up or referral)') has been adopted in many countries as a strategy for HPs to deliver all the important components of SCC.[25] Several studies have examined the performance of the 5As in pregnancy. Two reviews summarised the literature . Okoli et al's integrative review reported on HP performance of components of the 5As. While authors reported more than 50% of HPs Ask and Advise about smoking, and less than 50% Assess, Assist or Arrange (referral or follow-up), it is unclear how these estimates were calculated. This is an important limitation considering the variable ways studies collect data and report them,.[26] Baxter et al's qualitative systematic review, on the factors that influenced uptake of interventions by pregnant women, included studies on HP and women's reports of their receipt of SCC, and noted variation between HPs for recording smoking status and advice.[27] As neither review included a meta-analysis, it is timely and important from the point of view of rigour to have a definitive evaluation of HP practices, and furthermore to accurately inform recommendations to guide strategies to improve SCC. An urgent need for research to increase the uptake of smoking cessation interventions, and improve quit rates in pregnant women who smoke has been identified by Siddiqi and Mdege [28]

The objective of this systematic review was to summarise published empirical research of eligible studies from a range of HPs who consult with pregnant women who smoke, and synthesise findings with meta-analyses where feasible. The primary aim was to determine the prevalence of the components of SCC that were being practiced, including the 5As, prescribing NRT, and related behaviour change techniques (BCTs - observable and replicable components designed to change behaviour),[29] thus determine which aspects of SCC need improvement. A second aim was to examine which factors were associated with delivery of the 5As, and NRT prescribing i.e., HP types, country, year, and pregnant women in high-risk populations. We also examined data about knowledge and attitudes of the HPs to inform their practices.

Methods

Data were identified by searches of MEDLINE, EMBASE, CINAHL and PsycINFO, and reference lists from relevant articles. Where possible, search terms were matched to MESH or database specific subject headings, and used as keywords. Search terms included (Supplementary File Table A): pregnancy (e.g., perinatal care, mother), smoking (e.g., nicotine dependence, smoking cessation), health professional (e.g., general practitioner, midwife), and attitudes or practices (e.g., capacity, belief). Searches were performed in September 2015; additional studies included until June 2017.

Inclusion criteria: peer-reviewed full papers on SCC to pregnant smokers by any HP in any setting, restricted to English language, with no date restrictions. Quantitative studies and/or quantitative data from mixed methods studies with any study design were included, comprising self-reported provision of SCC by HPs, reported receipt of

SCC by pregnant women, or other indicators e.g., chart audit or audio-recordings of consultations. For this review, SCC was based on the 5As: asking about smoking, advising about quitting, assessing motivation to stop smoking or nicotine dependence, assisting to quit, and arranging follow up or referral.[25] In addition, we included papers reporting HP knowledge, attitudes, and other practices e.g., advising about relapse and smoke-free homes, discussing psychosocial contexts of smoking, involving family members or partners, prescribing NRT, and other BCTs (e.g., setting a quit date, making a quit plan, resources and self-help materials, and monitoring carbon monoxide readings).[30] Exclusion criteria: intervention studies and studies in non-peer-reviewed literature; studies on pre-conceptual and post-natal care. Additionally, 10 papers that did not have a main focus on the review topic and/or reported minimal data about the topic such as one line or one data item in a full paper, were excluded (list available from authors on request). The review was registered with PROSPERO 2015: CRD42015029989. We used the MOOSE checklist when writing our report.[31]

Two researchers (LT – behavioural scientist, YB - physician) independently screened titles, abstracts, and then full papers and applied the inclusion criteria to determine eligibility. Discrepancies were resolved by consensus, with a third researcher (GSG) acting as adjudicator, when agreement was not reached. Studies that met all criteria were retained for full review. One researcher completed data extraction (LS) with a second (YB) extracting 20% of articles, then results compared. A summary table (Supplementary File Table B) was developed from this data (GRG, GSG). The characteristics of each study were examined including aims, setting, country, sample characteristics, study focus (HP or women), HP type, study design and method, measures, extracted results for each of the 5As, and prescription of NRT.

As the studies overall were of all types of design, a quality assessment of the quantitative and mixed studies was carried out using Hawker et al's tool for reviewing disparate data systematically.[32] This was chosen in the absence on any consensus on the best tool, as we were including quantitative and mixed method studies in the review. LS rated all studies using the tool (20% double-rated by YB). Studies were included irrespective of quality.

Quantitative data were presented as percentages and counts were possible, and meta-analyses made for estimates of each of the 5As of SCC provision, and prescribing NRT. A narrative analysis summarises other studies or outcomes. For each outcome measure we looked at the specific measurements across studies to determine whether it was clinically appropriate to group them together i.e., Ask, Advise, Assess (motivation to quit, nicotine dependence), Assist (cessation support, quit date, quit plan, prescribe NRT), Arrange (follow up, referral). To achieve this, we considered both the data collection method (cross-sectional survey; audit of patients' medical records; audio-recording of consultation; women's report through survey or interview) and the measure itself that was used (e.g., Likert scale, or a dichotomous Yes/No response, and so forth). General principles applied were:

- **'Often/Always'** included survey measures reflecting asking 'often' and 'always', 'usually and always'; and/or 'most of the time' and 'all of the time'). The combined answers in Likert scales were dichotomised for analysis.
- **'Always/all'** included in this analysis was the proportion of HPs answering 'always' or 'all of the time', if a Likert scale was used, or the proportion answering 'Yes' if a dichotomous question was used: either asking 'do you ask all of your patients?' or 'do

you ask your patients always?' Answers reporting on 'Asking' more than 75% of their patients were considered as 'Yes' for these analyses.

- **'Yes'** where a survey asked the HP a dichotomous question for example 'Do you advise? Yes/No' were grouped separately as "Advise - Yes"

All statistical analyses were programmed using Stata v13.1 (StataCorp LP, College Station, TX, USA). Meta-analyses were performed to examine the performance of each of the 5As, including prescribing NRT, as above. Stata program *Metaprop* was used to pool dichotomized responses for each of the 5As. If more than 5 studies were pooled, random effects modelling (DerSimonian and Laird's method) was used to account for differences in underlying estimates due to study population and design; heterogeneity (I^2) was measured for each reporting type. If the number of studies was low (≤5), fixed effects modelling was used as there was not enough power to model the heterogeneity as having an underlying random distribution; heterogeneity is not presented. Where required, in order to include studies where the percent reporting the outcome was 100%, the Freeman-Tukey Double Arcsine Transformation method was used to stabilize the variances prior to pooling. Pooled estimates for study outcomes were split by response, and also by HP type. Significance was set as α=0.05 a priori.

For the 'often/always' responses to Ask, Advise, Assist, Arrange, including prescribing NRT, meta-regression (Stata program *Metareg*) was used to examine whether some of the heterogeneity seen in the proportions reported for each study could be explained by HP type (e.g. midwife, general practitioners (GP), obstreticians (OBS), or mixed groups of HPs), high-risk population versus not (e.g., women in low socio-economic groups, Indigenous women, or with mental health diagnoses), country (USA, Europe, Australia/New Zealand, or

Other), or year of publication (1990-2017). P-value, changes in heterogeneity (I^2 residual), changes in between study variance (τ^2), and proportion of between-study variance explained by predictor (adjusted R^2) were reported. For year, the linearity of proportion over time was examined, and if a non-linear trend was seen then the meta-regression was not performed.

An analysis of agreement of quality-rating coders was performed. Weighted kappa (ordinal multi-rater - quadratic weighted Kappa) was used to compare the rating of 9 quality study criteria for 15 studies; each criteria was scored on a 5 point scale (Very poor, Poor, Fair, Good, Very Good). Mean (SD) ratings were calculated for each criteria for each rater. Kappa and weighted kappa estimates were interpreted using cut-off criteria specified by Altman.[33] Strength of agreement was < 0.20 Poor; 0.21 - 0.40 Fair; 0.41 - 0.60 Moderate; 0.61 - 0.80 Good; 0.81 - 1.00 Very Good.

Results

Of the 3933 studies found, 54 papers met the inclusion criteria for quantitative review. See Prisma Flow Chart for included studies (Figure 1).

A total of 54 studies were included in this analysis.[34-87] Study details including author, country, study focus (HP, women, or both), population and risk category (high/low), study aims, inclusion of 5As, and summary of results are presented in Supplementary File Table B. Of these studies, approximately 90% were quantitative (n = 49), [34-40,42,45-61,63-72,74-87] and approximately 10% (n = 5) utilized mixed methods, containing both quantitative and qualitative aspects.[41,43,44,62,73] The included studies used the following study methods: survey

(n = 48),[34-42,45-59,61-64,66-78,81-87] audio-recordings (n = 2),[43,44] audit (*n* = 2),[79,80] audit with interview (n = 1),[60] and observational (n = 1).[65]

Study location included seven high income countries (United States of America,[34,42,46,51,54-56,58,62,68,75,76,83] United Kingdom,[41,45,49,57,71] Australia,[37,48,72,73,84,87] Germany,[78,81] Switzerland,[63] New Zealand,[52,53,77] France, [46]) and three low to middle income countries (Jordan, Argentina, and Urugauy).[28,32,59]

Included studies focused on either HPs (*n* = 39, 72%), [34,35,37,38,40,41,44-52,54-58,62,63,65-70,72,75-78,80,81,84-87] pregnant women (*n* = 12, 22%),[36,39,42,53,59,60,64,71,73,79,82,83] or both HPs and pregnant women (*n* = 3, 6%).[43,61,74] Studies encompassing HPs included obstetricians and gynaecologists (OBS) (*n* = 9, 21%),[35,46,50,51,54,62,68,70,76] midwives (*n* = 7, 17%),[34,38,48,49,61,69,81] general practitioners (GPs) (*n* = 3, 7%),[57,58,65] multiple professions (e.g., OBS, GPs, nurses, healthcare assistants; *n* = 21, 50%),[37,40,41,43-45,47,52,55,56,63,66,67,72,74,76-78,84,86,87] or did not report the profession (*n* = 1, 2%).[80]

Out of the 54 papers, information on Ask, Advise, Assess, Assist and Arrange (follow up/referral) was reported by approximately 68%, 70%, 28%, 63%, and 54% of studies, respectively. Few studies addressed all of the 5As combined (*n*=12, 22%). These reported that HPs rarely addressed all of the 5As, e.g. only 19.6% of respondents in Bar-Zeev et al's study of GPs and OBS performed all of the 5As 'often/always'.[37]

Only four studies (7%) addressed the provision of other BCTs in pregnancy. In one study, 31% of OBS advised women to set a quit date;[35] in a second study 29% of midwives suggesting quitting with an acquaintance;[49] 97% of women in a third sample reported they had not had their exhaled carbon monoxide tested,[53] and a fourth study reported which clinics used open-ended questions and problem solving.[86] Additionally, some studies (*n*=12, 22%),

obtained information on or addressed a woman's psychosocial context for smoking e.g., family or partner's smoking status or involvement in quitting, a woman's social support, or her living environment e.g., a smoke free home or vehicle (*n*=3, 6%). Information regarding the use of resources was addressed in 20 studies (37%), i.e., providing pamphlets or recommending online programs. Advise about relapse was rarely addressed in the included literature (*n*=3, 6%); e.g. in one of the studies midwives reported they discussed with women how to avoid relapse.[49]

Twenty-nine papers of the 54 papers addressed NRT in some capacity. These included knowledge and training, attitudes to NRT, and prescribing of NRT. Papers addressing knowledge, attitudes and training in general (*n*=14, 26%) also reported on HP knowledge about whether NRT can be used in pregnancy, and HP confidence about their smoking cessation knowledge, awareness of smoking cessation guidelines, knowledge about the consequences of smoking for expectant mothers, and risks to their baby. The majority of HPs believed maternal smoking to be harmful to the fetus and/or the woman, with reports ranging from 90-100%. General knowledge about smoking in pregnancy varied (e.g., in Bonollo et al,[40] only 44-52% of US HPs of various types, had correct knowledge). In Mejia et al's study 75% of Argentinan physicians believed it was safe to smoke up to six cigarettes when pregnant.[66]

In addition, the above group of studies included aspects of smoking cessation training (i.e., whether training had been offered, engaged in, and if more training was needed). In general, HPs reported they had received limited training on smoking cessation care in pregnancy, and identified that they required more training.

Papers including information on NRT prescribing (*n*=14, 26%) reported on the frequency of considering to prescribe NRT, the frequency of recommendation of NRT, frequency of

prescribing NRT, percentage of NRT scripts filled by women, percentage following FDA NRT prescription reccomendations, and the different NRT types prescribed (e.g., patches, gum, or inhalators). Overall findings suggested that HPs more often than not chose to not prescribe NRT to pregnant women who smoke, this was also supported by the meta-analysis below.

Attitudes and knowledge was associated with HP practices. In one Australian study, higher levels of knowledge about NRT were associated with greater likelihood of assessing women's smoking status.[72] In another US study, OBS who perceived NRT as safe to use in pregnancy were 20 times more likely to prescribe NRT.[75] An Australian study determined that HP optimism, and confidence in counselling and/or prescribing NRT, and having sufficient time and resources were associated with a higher performance of all the 5As.[37]

Thirty-three studies were suitable for meta-analysis.[34,35,39,41,42,45,46,48,49,51-55,57,58,62,63,66,68,71-73,75,77,78,81,84,87,88] Seventeen meta-analyses were performed and associated forest plots constructed (see Supplementary File Figures A to Q). Figure 2 provides a visual comparison for pooled percentatges of selected categories of 'often/always'.

Overall the performance of 'Ask – often/always' (*n*=9) was 91.6% (95% CI 88.2%, 95%). Percentages for 'Ask – 'always/all'' (*n*=11) was similar at 91.5% (95%CI 85%, 96.3%). Percentages for 'Ask –Yes' (n=4, all by womens report) was slightly higher at 93.6% (95%CI 92.6%, 94.6%).

The performance of 'Advise – often/always' (*n* = 7) was 90% overall (95%CI 72.5%, 99.3%). Percentages for 'Advise – always/all' (*n* = 6) was 86.4% overall (95%CI 79.6%, 93.3%). Percentages for 'Advise – Yes' (HP report) (*n* = 4) was much lower at 58.1% overall (95%CI 55.9%, 60.4%). Percentages for 'Advise – women's report Yes' (*n* = 4) was similar

at 53.6% overall (95%CI 52.6%, 54.6%). Percentages for 'Assess motivation to quit – often/always' (*n* = 3) was 79.2% overall (95%CI 76.5%, 81.8%).

Overall 34 manuscripts included a question about assisting. Some were generally asked about assisting the patient to quit, others specified a method of assisting such as counselling, setting a quit date, making a quit plan, and prescribing NRT. Those in the meta-analysis were as follows: 'Assist cessation support – often/always' (*n* =5) was 59.1% (95%CI 56%, 62.2%); 'Assist counselling – yes' (*n*=5) was higher at 80.7% (95%CI 79%, 82.5%); 'Assist quit plan – often/always' (*n*=2) was 57.6% (95%CI 54.1%, 61.1%); 'Assist quit date – often/always' (*n*=3) was low at 29% (95%CI 25.3%, 32.7%); 'Assist – women's report Yes' (*n*=4) was the lowest at 26.8% (95%CI 25.3%, 28.3%). The performance of 'Arrange referral – often/always' (n=6) was 33.3% overall (95%CI 20.4%, 46.2%). There was no analysable data on women's report for 'Arrange'.

'Prescribing NRT – Yes' was 25.4% (*n*=6) overall (95%CI 12.8%, 38%). 'Prescribing NRT – often/always' (*n*=4) however was very low at 12.8% overall (95%CI 10.7%, 15%). The performance of 'Prescribing NRT – always' (*n*=4) was the lowest at 6.2% overall (95%CI 4.9%, 7.4%). There was no analysable data on women's report of having been prescribed NRT.

High heterogeneity (I^2 =95.9- 99.1%) was seen for: 'Ask – often/always'; 'Ask – always'; 'Advise – often/always'; 'NRT prescription'; 'Arrange referral – often/always'; thus indicating considerable diversity in study outcomes, methodology, or populations. A fixed effects model was used for the following outcomes due to low number of studies, and heterogeneity was not measured: 'Ask – women's report Yes'; 'Advise – Yes'; 'Assess

motivation to quit – often/always'; all the 'Assist' categories; 'NRT Prescription – always', 'NRT Prescription – often/always'.

Table 1 displays the results of the meta-regression of the 'often/always' categories of 'Ask', 'Advise', 'Arrange', and 'Prescribing NRT' from the meta-analysis. 'Assist' only had 5 studies, so the meta-regression was not performed. For nearly all of the measures, none of the predictors examined significantly explained the heterogeneity of the proportions for the studies. For 'Arrange referral –often/always', country was found to explain some of the differences in proportion of HPs providing this type of smoking cessation care; with Australian and New Zealand studies having significantly higher proportions of HPs reporting 'Arrange referral – often/always' than USA studies (on average). Year was also found to explain some of the differences in proportion with later years having higher proportions of HP reporting this 'Arrange referral- often or always' (on average).

Table 2 shows the quality rating with the Hawker et al tool,[32] for included studies. Over 70% of the studies had some aspects at least that were rated as good.

Table 3 shows the ratings, and level of agreement from using the Hawker tool,[32] for the 15 papers that were rated independently by two raters. Coder agreement varied from Poor for two criteria, Fair for four of the criteria, and Moderate for three criteria.

Discussion

This systematic review of 54 studies from 10 countries on a range of HPs who consult with pregnant women who smoke. Thirty-three studies were suitable for meta-analyses for at least

one outcome measure. Studies displayed considerable variation in the way they assessed HP provision of each of the 5As. Commonly surveys employed Likert scales that were re-categorised as 'often or always', or questions forcing a 'Yes/No' option. We pragmatically transformed outcome measures so they could be combined for meta-analysis, over the 5As and their subcategories, resulting in small numbers of studies in each forest plot.

The primary aim to determine the prevalence of the components of SCC that were being practiced by a range of HPs. The review demonstrated several aspects of SCC that could be improved for pregnant women, including those seen in primary care settings. The highest rates were for Ask and Advise, and Assess. Assist and Arrange were consistently lower. Our secondary aim to examine whether SCC differed between different HP types, for pregnant women in high-risk populations, by country, and by year was achieved by meta-regressions of studies reporting practices 'often/always'. Only 'Arrange referral' had a significant result, indicating that year and country could explain some of the heterogeneity, and perhaps indicating an increased awareness of referral options in later years, or in Australia and New Zealand. The 21 studies not included in the meta-analysis, revealed few comparable quantitative studies on HP knowledge, attitudes and the lesser reported practices of BCTs, and the implementation of all components of the 5As together. On the whole HP knowledge base might be insufficient about NRT. Poor understanding about the safety or efficacy of NRT in pregnancy compared to continued smoking may lead to under-prescribing of NRT as a stop smoking aid, however this is likely to be context sensitive as not all countries recommend the use of NRT and clinical guidelines vary across time and even within the same country.[16] Access to HP training for SCC was reported as being limited, and HPs indicated they required more training.

The strength of this study is that, as far as we are aware, it is the broadest and most rigorous systematic review of HP performance of the 5As in pregnancy, including 7 high-income and three low to middle income countries and the only review, to our knowledge, to perform a meta-analysis and meta-regression. We took care to combine outcome measures with like measures, for each of the 5As, wherever possible. Multiple meta-analyses were performed, for each combined measure. The high heterogeneity suggests a cautious interpretation of the results. The review was limited by not being able to determine the cause for the high heterogeneity in the meta-analyses by our meta-regression, except for 'Arrange referral-often/always' which was related to year, and country. The quality rating revealed aspects of some papers were poor; findings from these studies may be less reliable. However discrepancies between the raters indicate a circumspect interpretation.

Two other reviews examined the provision by HP of SCC for pregnant women. Okoli et al's non-systematic review included 28 studies from 6 high-income countries (USA, Australia, UK, Germany, Canada, and the Netherlands).[26] The review reported that few HPs working with pregnant women use all the components of the 5As. Although more than 50% of HPs in the review asked women about their smoking status and advised pregnant smokers to quit, fewer than 50% assessed motivation, assisted smoking cessation, or arranged follow-up or referrals. Our review highlighted the diversity of the ways different studies surveyed HPs about their use of the 5As, but it is unclear from the Okoli review how these estimates were made. Instead a range was reported for each of the 5As, (for example 'Ask' 73-100%; 'Assess' readiness or willingness to make a quit attempt 42-81%) without the reader being able to determine which studies used Likert scales, if measures were re-categorised, or a dichotomous Yes/No employed. Baxter et al's systematic review included 23 papers from 6 high-income countries, one middle-income country (UK, France, Sweden, USA, Australia,

NZ, South Africa) and one multi-nation study, in a qualitative synthesis.[27] Similarly, although Baxter's review reports percentages of HP or women giving or receiving different aspects of the 5As, they do not describe how these questions were asked.[27]

The low rates of reported implementation of components of the 5As may be related to barriers at several levels. Okoli et al's review suggests several important provider-specific, patient-specific, and system or organizational barriers hindering the provision of SCC by HP.[26] Provider-specific barriers centred around HP self-efficacy or perceived ability to provide SCC to pregnant smokers, namely low knowledge, low confidence for counselling and use of NRT, the perception that as HPs they could not influence the patient's smoking behaviour, or that SCC was not their role. In the studies in our review, HP practices also related to HP knowledge and attitudes (optimism and confidence). Patient-level barriers included HP perceptions that pregnant smokers were not interested in quitting, had stressful lives, and HPs not wanting to jeopardise their relationship with the pregnant patient by raising smoking as an issue. System-level barriers included lack of time, resources, training and protocols, similarly described in our review. Baxter et al's review also reports barriers to providing SCC: discussing smoking cessation depended on whether HPs were able to broach the subject, staff confidence and perception of effectiveness, manner of communication, whether follow-up occurred, time and resource constraints, and service protocols.[27]

One of the included Australian studies explained some of the factors that may impinge on the quality of SCC for pregnant women. Bar-Zeev et al analysed the factors associated with performance of the 5As, and provision of NRT in Australian medical practitioners.[37] In a national study of 378 GPs and OBS, 'internal influences' (including HP confidence for counselling and prescribing NRT, optimism, sufficient time and resources) were associated with a higher likelihood of performing the 5As, whereas 'external influences' (i.e., workplace

routines, doctor-patient relationship, comfort raising the issue, perceived priority) were associated with performing the shorter version of Ask, Advise, Refer (AAR).[37,89,90] Furthermore, being an OBS compared to being a GP, low confidence, and uncertainty about safety of NRT, were associated with lower odds of prescribing NRT.[88]

Our objective to determine which aspects of SCC for pregnant women could need improvement, revealed on the whole that 'Assist' and Arrange' were less performed. Assisting pregnant smokers to quit is a vital priority. Unless there are high-quality specialised services to refer pregnant smokers to, it is insufficient for HPs to raise the issue, advise, and assess, without going further to actually assist a quit attempt, and as a duty of care arrange follow up or referral. Psychosocial support coupled with NRT (if needed, available and approved) may give pregnant women the best chance of quitting.[16,91] Various implementation strategies could be considered to improve SCC delivery to pregnant women, which may include HP education and training, promotion of clinical practice guidelines, audit and feedback, reminders, opinion leaders, incentives, or supervision.[92] Training was reported as an educational need by the HPs in the studies, and worthy of consideration. Training should most urgently focus on the elements of the 5As that are seldom performed, taking into account country-specific needs and guidelines. Training should provide actual skills to HPs in how to assist smokers to quit, and give opportunities to practice and receive feedback on their performance. Evidence-based updates on the use of NRT in pregnancy may be warranted especially if professional college guidelines are not up-to-date, with a caution about jurisdictions that may deter prescribing or access.[16]

Providing access to resources, such as educational and training materials for HPs, evidence-based and culturally-appropriate patient information sources, and affordable NRT, will

demand changes to policy in some settings and countries. Time is a perennial problem for HPs, however changes in practice protocols, and a whole-of-service approach, could support pregnant women to receive the time investment warranted by such an important issue for their own and their baby's health. Additionaly, policy changes to provide accessible and culturally-appropriate referral options are critical. Further research is warranted to understand which interventions can successfully improve HP performance of the 5As, and whether other models, such as the AAR,[92] the ABC (Ask, Brief Advice, Cessation),[93] or ABCD (Ask, Brief Advice, Cessation, Discuss)[94] approach may better facilitate HP implementation of SCC, and correspondingly improve quit rates in pregnant women. Standardised methods to assess the provision of SCC and the 5As in research or program evaluations, would aid future comparisons.

Conclusions

In a systematic review of HPs' provision of SCC for pregnant women in 10 countries, meta-analyses were performed after combining like measures across studies where feasible. Pooled percentages revealed that HPs reliably 'Ask', 'Advise' and 'Assess' pregnant women about tobacco smoking. 'Assist', including assist by 'prescribing NRT', and 'Arrange referral' were much lower, and may be improved by appropriate interventions such as training, incentives or prompts. Meta-regressions were significant only for 'Arrange referral' for year and country. Further research may be required to understand other factors driving the heterogeneity between different studies. Standardised methods to assess the provision of SCC and the 5As are warranted.

Author Statement: GSG was responsible for the design of the review, publishing the protocol in PROSPERO, oversaw all aspects of the study and wrote the manuscript. LT conducted the searches with YB. LS did the data extraction, and with YB the quality analysis. KP conducted the meta-analyses and meta-regressions. GRG assisted GSG in writing the methods and results sections, and preparing tables. BB advised on study design and critically reviewed the manuscript. YBZ advised on manuscript drafts as senior author. All authors reviewed and approved the final manuscript.

Declaration of interests

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Tables

Table 1: Meta-regression analysis of HP practices performed 'often/always'

Predictors	ASK	ADVISE	ASSIST	ARRANGE	NRT
N studies	9	7	5***	6	6
No predictors					
I^2 resid	96%	91.9%	72.9%	95.9%	97%
τ^2	0.008	0.0304	0.003	0.019	0.017
Provider type					
p-value	0.18	0.487	0.134	0.898	0.304
I^2 resid	95.6%	87.7%		97.4%	94.8%
τ^2	0.006	0.031		0.029	0.013
High risk					
p-value	0.909	**	0.43	0.62	**
I^2 resid	96.4%			96.7%	
τ^2	0.009			0.021	
Country					
p-value	0.845	0.252	0.185	0.037	0.903
I^2 resid	96.5%	89.4%		84.5%	97.6%
τ^2	0.012	0.022		0.006	0.021
Year					
p-value	*	*	*	0.013	*
r^2 resid				73.9%	

** non-linear, **model not performed, ***too few studies*

Table 2: Quality assessment of 54 included studies

Author (year)	Abstract and title	Intro and aims	Method and data	Sampling	Data analysis	Ethics and bias	Results	Transferability	Implications and usefulness
Abatemarco (2007)	Good	Good	Fair	Good	Fair	Fair	Poor	Good	Good
Amarin (2005)	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Fair
Bakker (2005)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair
Bar Zeev (2017)	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good
Beenstock (2012)	Good	Good	Good	Good	Good	Fair	Good	Good	Good
Berruetas (2016)	Fair	fair	Fair	Good	Fair	Fair	Good	Good	Good
Bonollo (2002)	Good	Good	Good	Fair	Good	Good	Fair	Fair	Fair
Bull (2006)	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Good
Castrucci (2006)	Fair	Fair	Fair	Fair	Fair	Very poor	Fair	Fair	Fair
Chang (2008)	Good	Good	Good	Fair	Fair	Good	Fair	Fair	Fair
Chang (2013)	Fair	Good	Good	Fair	Good	Good	Fair	Fair	Good
Clasper (1995)	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Coleman-Cowger (2014)	Good	Fair	Good	Good	Fair	Very poor	Fair	Fair	Good
Condliffe (2005)	Good	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair
Cooke (1996)	Good	Fair	Fair	Good	Good	Fair	Good	Good	Good
Cooke (1998)	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair
Eiser (1999)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair
England (2014)	Good	Good	Fair	Good	Good	Good	Good	Good	Good
Floyd (2001)	Fair	Fair	Fair	Poor	Fair	Fair	Fair	Poor	Fair
Glover (2008)	Fair	Fair	Poor	Fair	Poor	Fair	Fair	Fair	Fair
Grange (2006)	Poor	Fair	Poor	Fair	Fair	Poor	Fair	Fair	Fair

Grimley (2001)	Good	Good	Good	Good	Fair	Good	Good	Fair	Good
Hartmann (2007)	Good	Good	Good	Fair	Fair	Good	Good	Fair	Fair
Helwig (1998)	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Herbert (2005)	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Hickner (1990)	Fair	Poor	Fair	Fair	Fair	Poor	Fair	Fair	Fair
Hoekzema (2014)	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair
Howard (2013)	Good	Good	Good	Good	Good	Good	Good	Fair	Good
Jones (2003)	Good	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Jordan (2006)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Good
Lemola (2012)	Good	Good	Good	Good	Good	Fair	Good	Good	Good
Mabbutt (2002)	Good	Good	Fair	Poor	Fair	Fair	Good	Poor	Fair
McEwen (2003)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mejia (2010)	Good	Fair	Fair	Good	Fair	Poor	Fair	Fair	Good
Moran (2003)	Fair	Good	Good	Good	Good	Poor	Good	Good	Good
Mullen (1998)	Fair	Good	Fair	Fair	Good	Poor	Fair	Fair	Fair
Murphy (2016)	Fair	Fair	Fair	Good	Fair	Good	Fair	Good	Good
Oncken (2000)	Good	Fair	Good	Good	Good	Poor	Good	Good	Fair
Owen (1999)	Poor	Fair	Poor	Very poor	Poor	Poor	Poor	Fair	Fair
Passey (2012)	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Good
Passey (2015)	Fair	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair
Passey (2014)	Fair	Fair	Fair	Fair	Good	Fair	Good	Fair	Good
Price (2006)	Good	Fair	Good	Fair	Good	Poor	Good	Fair	Good
Price (2006)	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Pullon (2004)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair
Roske (2009)	Good	Good	Fair	Good	Good	Fair	Good	Good	Fair
Solberg (2010)	Good	Good	Good	Good	Good	Good	Good	Good	Good
Tappin (2010)	Fair	Fair	Fair	Good	Poor	Fair	Fair	Fair	Fair
Thyrian (2006)	Good	Good	Good	Good	Good	Good	Good	Good	Good
Tong (2008)	Good	Good	Fair	Good	Fair	Poor	Fair	Good	Fair
Tran (2010)	Good	Fair	Good	Good	Good	Fair	Good	Good	Good
Tzelepis (2017)	Good	Fair	Good	Good	Good	Good	Good	Good	Good
Walsh (1995)	Good	Fair	Good	Fair	Fair	Fair	Good	Fair	Fair
Zapka (2000)	Good	Fair	Good	Fair	Good	Fair	Good	Fair	Fair

NA – not applicable as was a letter to the Editor

Table 3: Findings from agreement analysis of coders

	Mean Rating (SD) *1 (very poor) to 4 (good)*		*Agreement*	
Study Criteria	***Rater 1***	***Rater 2***	***Weighted kappa (95%CI)***	***Agreement***
Abstract and title	2.4 (0.6)	2.3 (0.6)	0.13 (-0.41, 0.68)	Poor
Intro and aims	2.3 (0.5)	2.1 (0.3)	0.25 (-0.17, 0.67)*	Fair
Method and data	2.2 (0.6)	2.3 (0.6)	-0.15 (-0.74, 0.43)	Poor
Sampling	2.1 (0.8)	2.3 (0.6)	0.43 (0.10, 0.76)	Moderate
Data analysis	2.1 (0.6)	2.1 (0.5)	0.51 (0.03, 0.99)	Moderate
Ethics and bias	1.9 (0.8)	1.9 (1.0)	0.38 (0.13, 0.63)	Fair
Results	2.3 (0.7)	2.4 (0.5)	0.26 (-0.11, 0.62)	Fair
Transferability	2.2 (0.4)	2.3 (0.6)	0.21 (-0.19, 0.61)	Fair
Implications and usefulness	2.4 (0.6)	2.5 (0.6)	0.58 (0.18, 0.98)	Moderate

*only 2 levels, therefore Kappa rather than weighted Kappa used

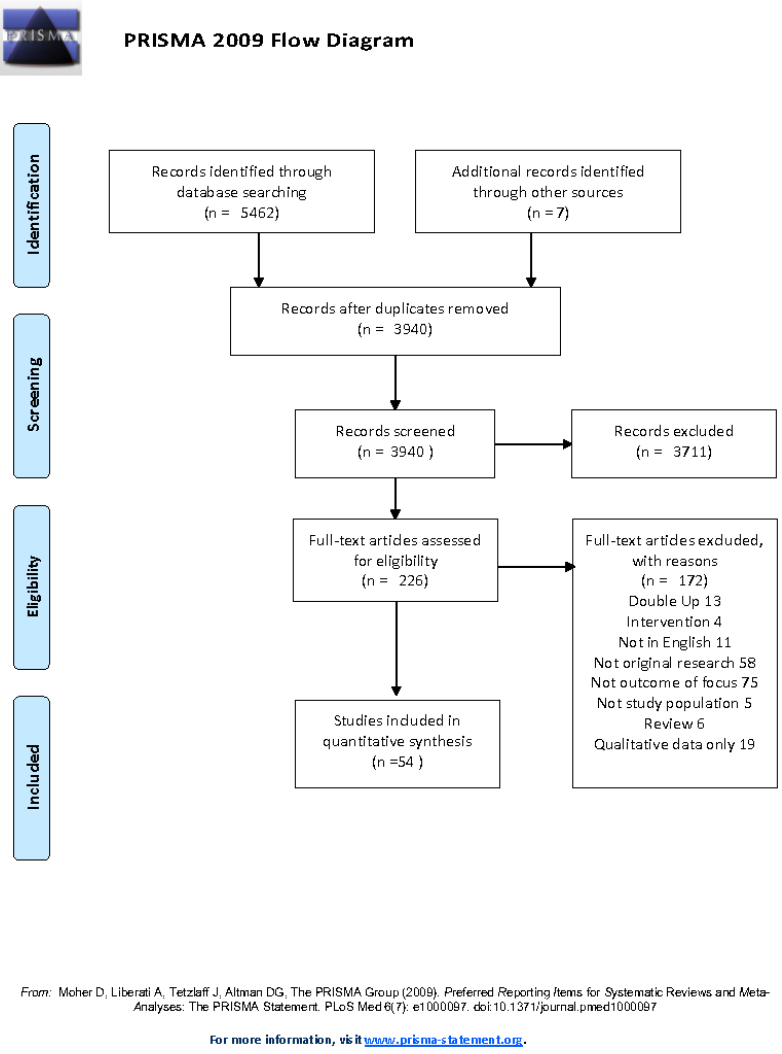


Figure 1: PRISMA Flow Chart of study selection

215x279mm (106 x 106 DPI)

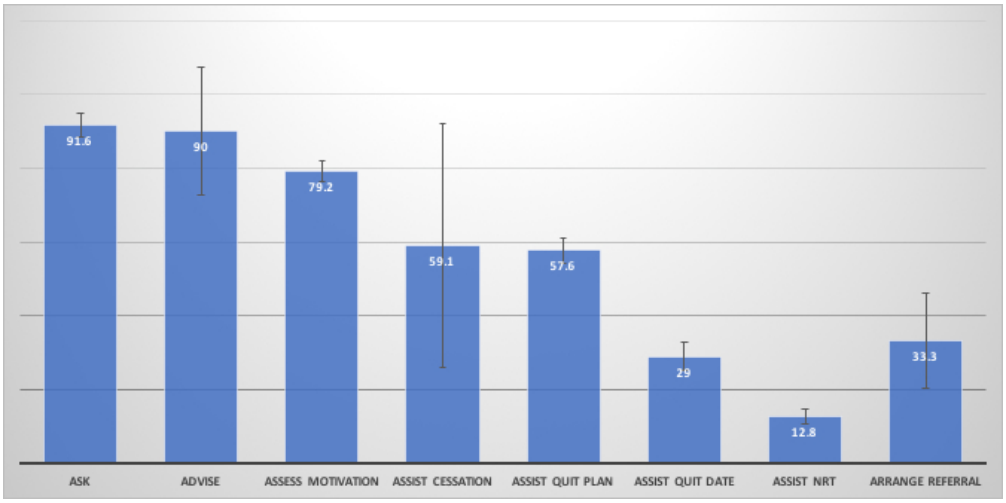


Figure 2: Pooled percentages of HP self-report of performance of the 5As 'often/always'

237x117mm (72 x 72 DPI)

Supplementary File

Supplementary Table A: Key search terms for systematic review on Health Providers' Practices for Smoking Cessation Care in Pregnancy

Health Professional	Attitudes and Practices	Smoking	Pregnancy
Allied health personnel	Health Knowledge, Attitudes, Practice	Tobacco dependence treatment	Maternal behaviour
General practitioner	Attitude of Health Personnel	Maternal tobacco smoking	Perinatal Care
Medical practitioner	Knowledge	Smoking Cessation	Pregnancy
Health Professional	Perception	Tobacco use disorder	Maternal
Health personnel	Practice	Nicotine dependence	Mother
Family Practice	Belief	Smoking treatment	Preg*
Specialist	Capacity	Smoking	Antenatal
Physician	Capability	Smok*	
Doctor	Confidence	Tobacco	
Midwife	Priority		
Gynaecology	Barrier		
Obstetrics	Attitude		
Clinician	Skill		
Dentist	Ability		
Pharmacist			
Consultant			

Note: all search terms were "exploded", meaning the terms underneath these keywords were also searched for.

Supplementary Table B: Characteristics of included quantitative (N=54) studies

First Author (year) Country	Study Focus	Population & Risk Category (high/low)	Study Aim(s)	Ask	Advise	Assess	Assist	Arrange follow up	NRT	Summary of results
Abatemarco (2007) USA	Health Providers (Midwives)	Low risk	Determine how New Jersey's certified nurse-midwives (CNMs) provide tobacco screening and cessation counselling to pregnant smoking women.	X	X	X	X	X		Nearly all midwives routinely ask, advise, and assess; while fewer address quit dates, or discuss medication options (assist) and perform follow-up activities (arrange). Midwives identify a need for training.
Amarin (2005) Jordon	Health Providers (Obstetrician & Gynaecologists)	Low risk	Establish tobacco use amongst obstetricians/gynaecologists and assess awareness of the impact of smoking on health; routine practices with patients who smoke; opinions of factors contributing to tobacco use and their perceived barriers to counselling improvements.	X	X		X			A high proportion of obstetricians/gynaecologists are smokers. Most health professionals associated smoking with low birth weight and sudden infant death syndrome. Fewer associated smoking with infertility, ectopic pregnancy, placenta praevia, abruption placentae and cancer of the uterine cervix. Friends, stress, parents' attitude, genetic predisposition, income and education were implicated factors for smoking. Current smokers were more likely to permit smoking in their practices. Non-smokers were most inclined to record their patients' tobacco habits. Only 54.3% provided cessation counselling. Lack of time and inadequate training were perceived barriers.
Bakker (2005) Netherlands	Pregnant Women	Low risk	To identify relevant factors that hamper or promote the provision of effective smoking cessation advice and counselling.			NA*				In general, midwives were motivated to provide their clients with smoking cessation advice, however, were less comfortable guiding women through the cessation process.
Bar-Zeev (2017) Australia	Health Providers (GPs & Obstetricians)	Low risk	Examine: 1) Self-reported provision of SCC to pregnant women by GPs and Obstetricians in Australia; 2) Barriers and enablers to SCC and 3)	X	X	X	X	X	X	Almost all clinicians (98%) reported that addressing smoking during pregnancy is a high priority, and that they feel comfortable raising the issue with a pregnant woman (95%). TDF statements receiving the lowest agreement(agree & strongly agree) were having sufficient time (41%), sufficient resources (47.5%) and optimism of intervention effectiveness (35%). Dimension reduction revealed two factors: 1) 'Internal influences' including confidence in counselling, confidence in prescribing NRT, optimism, sufficient

			Associations between health professionals (GP/Obstetrician), knowledge, attitudes, and performance of SCC."						time and resources; 2) 'External influences' including high priority, benefit relationship, workplace routine, and comfortable raising the issue. Compared to NFASTIH GPs, being an Obstetrician was associated with lower performance of all the 5A's, but with a higher performance of AAR. No difference was found between the performance of the RANZCOG GPs and Obstetricians. 'Internal influences' were associated with a higher performance of all the 5A's, whereas 'External influences' were associated with a higher performance of AAR. Performing all the required 5A's was done by less than 20% of participants and was associated with barriers that are internal such as low confidence and low optimism. Internal barriers includes confidence in counselling, confidence in prescribing NRT, optimism in intervention effectiveness, sufficient time and resources. External barriers includes high priority, benefit relationship, workplace routine, comfortable raising the issue.
Beenstock (2012) UK	Health Providers (Midwives)	Low risk	Investigate the perceived implementation difficulties of midwives in providing smoking-cessation advice to pregnant smoking women. Investigate relationships between the self-reported behaviour of referring women to smoking-cessation services and demographic and professional variables.			NA*			Midwives were less certain about the consequences of, and the environmental context and resources available for, engaging in this work relative to other TDF domains. The 'propensity to act' was predictive of the self-reported behaviour 'Refer all women who smoke.....to NHS Stop Smoking Services' and mediated the relationship between demographic variables (e.g., midwives' workplace and behaviours). This study supports previous research that the TDF is an appropriate tool to understand the behaviour of healthcare professionals.
Berruetas (2016) Argentina & Uruguay	Pregnant Women	High Risk-Economic-ally deprived	Assess smoking patterns and receipt of 5A's among pregnant women in Buenos Aires, Argentina and Montevideo, Uruguay.	X	X	X	X	X	Among pregnant smokers in Argentina, 23.8% reported that a provider asked them about smoking at more than one prenatal care visit; 18.5% were advised to quit; 5.3% were assessed for readiness to quit, 4.7% were provided assistance, and 0.7% reported follow-up was arranged. In Uruguay, those percentages were 36.3%, 27.9%, 5.4%, 5.6%, and 0.2%, respectively.
Bonollo (2002) USA	Health Providers (Physicians, Nurses, Practitioner, & Nutritionists)	Low risk	To examine in detail the specific content and levels of knowledge among providers caring for low-income pregnant and postpartum women to present a current perspective on counselling related to tobacco addition. Explore provider characteristics related to knowledge levels.			NA*			Providers reported low awareness of the health risks of smoking to the developing foetus/child of pregnant and postpartum women and of the effectiveness of nicotine replacement therapy (NRT) for doubling quit rates. Obstetric (OB) and WIC providers were more aware than PED providers that provider-delivered interventions are effective. Confidence in using counselling steps was significantly associated with general and NRT-related knowledge. NRT-related knowledge, but not general knowledge, was associated with higher performance of intervention steps. Educational programs targeting OB, WIC, and PED providers' knowledge about effective smoking cessation counselling strategies and their confidence in being effective with patients are needed.
Bull (2006) UK	Health Providers (Health Visitors, Midwives, And Nurses)	Low risk	To examine the attitudes, knowledge and practice of health visitors, midwives and practice nurses in	X	X	X	X	X	All health practitioners claimed to ask if their patients smoked. Most claimed to record smoking status on health records and give cessation advice. Fewer provided advice to partners of women in their care and only a minority had read the NICE clinical guidelines on NRT.

			relation to smoking cessation interventions with pregnant women and new parents.							
Castrucci (2006) USA	Pregnant Women	Low risk	Describe the range of risk reduction behaviours among women who continue to smoke after learning of their pregnancy, including reduce tobacco use, eventual cessation and sustained abstinence as well the patient-reported smoking cessation - promoting behaviours of prenatal care providers.				X	X		Smoking cessation was achieved by only a quarter of antenatal smokers, almost 90 percent reduced their cigarette consumption. Antenatal smokers reported that prenatal care providers asked about their smoking (90.6%) and advised about quitting (76.5%). However, only 27.9% were given referrals to smoking cessation programs.
Chang (2008) USA	Pregnant Women & Health Providers (Obstetrics-Gynaecology Resident, Nurse Midwife, & Nurse Practitioner)	Low risk	Examine patient-provider communication about substance use behaviours during obstetric visits.	X	X	X	X	X		Provider responses to smoking disclosures included discussions of risks, encouragement to quit-cut down, affirmation of attempts to quit-cut down, and referral to smoking cessation programs. Providers should discuss behavioural change strategies and motivations with pregnant patients who use substances.
Chang (2013) USA	Health Providers (Nurse Midwife, Nurse Practitioner, Residents, Physician Assistant)	Low risk	Describe obstetric providers' adherence to the evidence-based clinical practice guideline for smoking cessation counselling, the 5 A's (Ask, Advice, Assess, Assist, and Arrange).	X	X	X	X	X	X	Obstetric providers frequently asked about smoking (98%) however, used 3 or more of the 5 A's in only 21% (24) of visits. In no visits did providers use all 5 A's.
Clasper (1995) UK	Health Providers (Hospital Midwives, Community Midwives, General Practitioners, Obstetricians)	Low risk	To inform the development of future smoking cessation interventions in pregnancy by measuring current practice and the associated attitudes and beliefs of the main professionals responsible for the delivery of antenatal care.	X	X		X	X		Most professionals asked about the smoking status of pregnant women, record smoking status and explain the risks of smoking while pregnant. Fewer professionals gave pregnant smokers advice on how to stop or monitored at and reviewed smoking status throughout pregnancy. Most experienced difficulty and a lack of enjoyment while giving smoking cessation counselling. Over half (53%) perceived themselves to be insufficiently trained, whilst few (28%) thought that they possessed the necessary skills.

Coleman-Cowger (2014) USA	Health Providers (Obstetrician & Gynaecologists)	Low risk	To assess current ob-gyn practice patterns related to the management of and barriers to smoking cessation during pregnancy and postpartum.	X	X	X	X	X	X	Ob-gyns estimated that approximated that 32% of pregnant smokers quit during pregnancy, but 50% return to smoking postpartum. The primary barrier was time limitations. Compared with findings from a similar study conducted in 1998, physicians are less likely to adhere to the 5 As smoking cessation guideline at present.
Condliffe (2005) USA	Health Providers (Midwives Grandes E-H, Health Care Assistants)	Low risk	Explore the self-reported smoking-cessation interventions of maternity staff with pregnant smokers and their attitudes towards smoking in pregnancy.		X	X		X		Over two-thirds of respondents (71%) reported not advising any pregnant women to give up smoking within the previous 7 days. However, 64% felt women should not make up their own minds about whether to smoke during pregnancy, and 81% agreed/strongly agreed that many pregnant women would like to give up smoking but need help and advice on how to succeed. Helping a pregnant woman to give up smoking was seen as being one of the most important things a midwife can do by 73% of the respondents. Although the reported attitudes were supportive of the midwife's role in smoking cessation, they did not translate into practice. The level of smoking cessation interventions was low.
Cooke (1996) Australia	Health Providers (Midwives)	Low risk	Assess current practice in smoking cessation interventions by midwives and to examine the relationship between the use of smoking interventions, practitioner's characteristics, and organisational factors.	X	X		X	X		Most midwives used minimal interventions (advice and education) for at least some of their clients. The more skilled and more time-intensive forms of intervention (e.g., counselling, negotiating a quit date, and follow-up) were infrequently utilized. Participants estimated that half their smoking clients were not offered advice about smoking. Organizational factors such as: hospital policy for smoking intervention, type of hospital, size of hospital, cohesion of staff and work pressure predicted the use of smoking interventions. Self-reported ability to intervene for smoking and the level of assessment undertaken were practitioner characteristics which predicted the use of smoking interventions. The barriers that inhibit the use of smoking intervention by midwives are discussed and methods for change canvassed.
Cooke (1998) Australia	Health Providers (Midwives, Doctors: Obstetric Specialists, Registrars and Residents)	Low risk	The aims of the study were to describe the smoking intervention practice of antenatal clinic staff, and to ascertain the organizational and practitioner variables which predict clinician use of smoking interventions.	X	X		X	X		Most antenatal clinic staff did not use the most effective forms of brief interventions for smoking. The presence of specific procedures and training in smoking cessation intervention appeared to be the most important predictors of reported smoking intervention in hospital antenatal clinics.
Eiser (1999) UK	Health Providers (Midwives)	Low risk	Assess a) their attitudes to giving anti-smoking advice to pregnant smokers and whether they perceived this as part of their professional role and b) the types of advice they gave to pregnant smokers as part of their routine practices.	X	X	X	X			Midwives attitudes towards giving anti-smoking advice were generally positive, and almost all reported routinely explaining the health dangers of smoking to pregnant smokers. Among midwives who had never smoked, those who held role attitudes that were more favourable towards anti-smoking intervention reported providing relatively more advice based on warnings of health consequences and an emphasis on abstinence. Among the remainder of the sample, more favourable attitudes predicted greater use of behaviourally-oriented advice to facilitate cessation or smoking reduction, but were unrelated to the use of health warnings and emphasis on abstinence.
England (2014) USA	Health Providers (Obstetrician-	Low risk	Examine screening practices and attitudes of obstetricians-			NA*				A substantial proportion of obstetrician-gynaecologists reported never or inconsistently screening their pregnant patients for the use of non-combustible tobacco products.

	Gynaecologist Physicians)		gynaecologists toward new and emerging tobacco products.							Responses regarding the harms of these products relative to cigarettes were mixed and most respondents wanted more information.
Floyd (2001) USA	Health Providers (Obstetric-Gynaecologists)	Low risk	Assess the knowledge, beliefs and practice behaviours of obstetricians/ gynaecologists concerning their patients prenatal use of tobacco and other drugs.	X	X		X	X	X	While screening of prenatal patients for tobacco use and other drug use was reported by survey respondents, providing or arranging for interventions for those screening positives was less often reported.
Glover (2008) NZ	Health Providers (GPs, Registered Midwives)	Low risk	To examine New Zealand general practitioners' GP and midwives' smoking cessation knowledge and support offered to pregnant women who smoke.	X	X	X	X	X	X	GPs are in the ideal position to offer stop-smoking advice, because they usually confirm pregnancy. GPs are most likely to advocate stopping smoking completely; midwives are more likely to advocate cutting down with a view to quitting. Both GPs and midwives would benefit from improved knowledge of the full range of nicotine replacement therapy (NRT).
Grange (2006) France	Pregnant Women	Low risk	To describe the management of tobacco withdrawal in pregnant women.	X	X	X	X			Healthcare professionals seems to offer only rudimentary care. Simple strategies to help women give up smoking are required. The partner is an important target, especially if he can be persuaded to give up at the same time.
Grimley (2001) USA	Health Providers (Obstetrician & Gynaecologists)	Low risk	To determine the adherence to the clinical guidelines for smoking cessation among Ob-gyn physicians within Alabama.	X	X	X	X	X	X	Interventions are needed to motivate, support, and guide OB-GYN physicians to assist and follow-up with their pregnant patients who smoke.
Hartmann (2007) USA	Health Providers (Obstetricians, Midwives, Family Medicine Physicians, Nurse Practitioners and Physician Assistants)	Low risk	To measure the use of best practice intervention including each of the 5 A's and to assess the relationship between best practice and current intervention resources, prior training in smoking cessation intervention and barriers to providing intervention.	X	X	X	X	X	X	Best practice is well-established to promote prenatal smoking cessation yet implemented by only one third of prenatal care providers in North Carolina. In this study, best practice was associated with resources, practice organization, and reimbursement. Augmented use of available resources (e.g., toll-free hot-lines) and adequate reimbursement may promote best practice implementation.
Helwig (1998) USA	Health Providers (Obstetricians, Family Physicians, Midwives)	Low risk	Investigate the usual intervention practices of family physicians, obstetricians, and nurse midwives for their patients who smoke.	X			X	X	X	Maternity care providers underutilize effective methods of smoking cessation for their patients who smoke and rely on less effective methods.
Herbert (2005) UK	Health Providers (GPs)	Low risk	Determine a). General practitioners' confidence in their ability to deliver a range of smoking cessation interventions, including		X			X	X	Most general practitioners (62%) believed NRT to be effective in pregnancy and safer than smoking (70%), but fewer (45%) believed NRT to be safe in pregnancy. GPs who believed NRT use in pregnancy was safer than smoking were most likely to recall having prescribed it. Many general practitioners were unsure about the safety of NRT in

			NRT in pregnancy, b). the frequency with which general practitioners recall prescribing NRT in pregnancy and c). The factors that influence general practitioners to prescribe NRT in pregnancy.						pregnancy. The key factor influencing general practitioners' prescribing decisions was a belief that NRT use in pregnancy was likely to be safer than smoking.
Hickner (1990) USA	Health Providers (Family Physicians)	Low risk	Reports practitioner's attitudes and strategies towards antismoking interventions for pregnant smokers.	X	X		X	X	X	Most physicians routinely assessed smoking status at the first prenatal visit, and advised pregnant smokers to quit smoking during pregnancy. The most frequently used method of intervention was personal counselling (97%), referral to smoking cessation clinics (40%), and behaviour modification (20%). Fifty-seven percent of physicians reported using antismoking pamphlets, and 30% used antismoking posters. 97% were convinced that the benefits of smoking cessation during pregnancy merited their efforts.
Hoekzema (2014) Australia	Pregnant Women	Low risk	To characterise pregnant smokers and to understand their smoking behaviours and preferences for smoking cessation. The specific objectives were to study the smoking patterns, smoking cessation and treatment preferences of pregnant women and to investigate the scope for a smoking cessation program in the antenatal settings.		X		X		X	There were 87 (69.6%) daily smokers and 38 (30.4%) occasional smokers. Smokers mainly had medium (54; 43.2%) or heavy nicotine dependence (45; 36%). Current smokers were younger, Australian born, not living with a partner, from a lower socio-economic background, multigravida and had a smoker in their household or among friends. Although pregnant smokers were aware of the possible complications of smoking, their motivation and confidence to quit (median) on a 10-point scale were 7 and 4, respectively. Most smokers preferred to stop smoking gradually (74; 71.2%). The preferred methods for quitting were medications (49; 47.6%) and hypnotherapy (35; 34.0%). Patches (28; 29.5%) were the preferred dosage form, and nicotine replacement therapy (25; 28.1%) was the preferred medication. Less than half reported that their health professionals discouraged smoking during pregnancy.
Howard (2013) UK	Pregnant Women	High risk – women with mental illness	Investigate whether pregnant women with mental disorders: a). Are less likely to accept referrals to smoking cessation services, b) are less likely to stop smoking by delivery, and c). Differ in their experiences of smoking, smoking cessation and smoking cessation services compared with pregnant women without mental disorders.				X	X		Pregnant women with mental disorders appear more motivated, yet find it more difficult, to stop smoking. Prioritisation of mental health over smoking may thus lead to increasing health inequality for this group.
Jones (2003)	Pregnant Women &	Low risk	Explore the attitudes of midwives and pregnant		X		X			Only 45% of midwives offered smoking cessation advice routinely, although 82% felt it should be a part of the antenatal care (82%). Lack of time (66%) and training (54%) were

UK	Health Providers (Midwives)		women towards smoking cessation advice to understand why it is not a routine part of antenatal care.							the major reasons for this. Smoking cessation advice was not a priority for discussion among the midwives compared to topics such as antenatal screening or place of delivery. Women were aware of the dangers of smoking in pregnancy, but those who wanted to quit need more support from their midwives (83%). They ranked smoking cessation as a high priority for discussion at the antenatal visit. The midwives did not feel able to offer smoking cessation advice. The main reason being a of lack of time in the antenatal clinic.
Jordan (2006) USA	Health Providers (Obstetricians, Gynaecologist)	Low risk	To assess Ohio obstetrician/gynaecologists' perceptions and use of the 5A's methods of smoking cessation with pregnant patients who smoking.	X	X	X	X	X	X	Obstetrician/gynaecologists face many competing demands for their time and energy, yet 62% believed smoking cessation advice would be of significant value. Physicians with higher levels of efficacy expectations reported significantly greater use of the 5 As. Future research should explore ways to facilitate obstetrician/gynaecologists' use of the 5As method.
Lemola (2012) Switzerland	Health Providers (Gynaecologists, Midwives)	Low risk	Examined whether gynaecologists and midwives engage in screening and counselling of pregnant women and conducting interventions to prevent smoking during pregnancy. Examine control beliefs involving efficacy expectations of practitioner.	X	X		X			Most gynaecologists and midwives reported screening all pregnant patients regarding smoking, explaining the risks and recommending smoking cessation. By contrast, only a minority engages in more extensive prevention efforts. Strong control beliefs were predictive of a higher likelihood of screening and counselling, as well as of engaging in more extensive interventions.
Mabbutt (2002) Australia	Pregnant Women	Low risk	To examine substance use among pregnant women and their partners, to record changes in reported substance use during pregnancy and to determine what advice they received to stop smoking.		X					Routine advice to quit smoking was not the norm for this group who were motivated to attend antenatal classes and possibly more likely to act on quit smoking advice. Of the women and men who did receive advice to quit smoking, the majority of this advice was not from a health professional. Routine advice about quitting smoking should be a mandatory part of antenatal care, especially for disadvantaged groups, where smoking rates are higher. The antenatal setting accesses most pregnant women and provides a population base for comprehensive anti-smoking strategies for them and for their partners. Failure to implement such strategies would be to miss the opportunity for a cost-effective and disseminable public health intervention for pregnant women and their male partners.
McEwen (2003) UK	Health Providers (GPs)	Low risk	Investigate methods of early referral of pregnant smokers.	X				X		From a total of 55 GPs, in 17 practices within a deprived area of South West London, according to predictions from the delivery figures for the previous year, approximately 120 pregnant smokers should be identified within the 9-month period that the study took place. GPs were invited to use whatever form of referral was most convenient to them. Only 8 referrals were received.
Mejia (2010) Argentina and Uruguay	HEALTH PROVIDERS (Obstetricians, Gynaecologists, & Residents)	Low risk	To describe physicians' practices of smoking cessation and second-hand smoke exposure counselling during prenatal visits.	X	X				X	Although 88.9% of practitioners always or almost always advised women to stop smoking, 75% believed it was acceptable for pregnant women to smoke up to 6 cigarettes per day. The risk of SHS exposure was 'always or almost always discussed' by only 34.5% of physicians. Multivariate logistic regression showed that lack of training was associated with less counselling about smoking cessation (OR 0.18; 95% CI 0.04-0.82) and SHS exposure (OR 0.27; 95% CI 0.12-0.59). Current compared to never smokers had lower odds of smoking cessation counselling (OR 0.39; 95% CI 0.05-0.82). Current

									smokers were less likely than former smokers to counsel about SHS (OR 0.25; 95% CI 0.11-0.62).
Moran (2003) USA	Health Providers (Family Practitioner, General Practitioner, Obstetrician, & Gynaecologist)	Low risk	To assess how frequently physicians identified the smoking status of pregnant patients and how frequently physicians counselled pregnant smokers.			X			Physicians identified pregnant women's smoking status at 81% of visits but provided smoking counselling at only 23% of visits by pregnant smokers. Physicians were less likely to identify smoking status of non-White pregnant women but no less likely to counsel non-White smokers.
Mullen (1998) USA	Health Providers (Obstetricians)	Low risk	To describe Texas obstetricians' pregnancy smoking cessation counselling activity and to identify attributes associated with consistent, effective counselling.	X		X	X	X	Obstetricians who are not reached by expert reports and guidelines from groups outside their specialty or who do not perceive the seriousness of maternal smoking are less likely to counsel consistently and to use the most effective techniques.
Murphy (2016) South Africa	Health Providers (Midwifes)	Low risk	to assess the knowledge, attitudes, beliefs and current practices of South Africa midwives in relation to providing smoking cessation education or counselling to pregnant women.	X	X				This study identified several constraints to midwives fulfilling this role, which affected their perceived behavioural control. These included stressful working conditions, too little time, a dearth of educational resources and a lack of knowledge of best practice intervention methods and counselling skills. Perceived patient resistance to quitting was a further obstacle.
Oncken (2000) USA	Health Providers (Obstetrics & Paediatric)	Low risk	To assess smoking cessation counselling and nicotine replacement therapy prescription and recommendation practices among obstetric and paediatric providers.		X			X	We found that nicotine replacement therapies are commonly prescribed or recommended to pregnant smokers by obstetric providers, but less commonly to lactating women by paediatric providers.
Owen (1999) UK	Pregnant Women	Low risk	Examines pregnant women's reports of quality and quantity of health professional interventions from 1992 – 1999.		X				Less than 50% of pregnant smokers reported having received advice on smoking from a health professional during their current pregnancy: little change since the question was first asked in 1994. Advice, when given, appeared to have had little impact on smoking cessation, and did not follow best available evidence, namely to quit rather than cut down.
Passey (2012) Australia	Health Providers (AHW, Midwives or Nurses, Doctors)	High Risk-women Aboriginal and Torres Strait Islander	Aims to explore the knowledge and attitudes of health care providers caring for pregnant Australian Aboriginal women regarding smoking risk and cessation and identify factors associate with self-	X				X	Most respondents considered assessment of smoking status to be integral to antenatal care and a professional responsibility. Most (79%) indicated that they assess smoking status in 100% of clients. Knowledge of risks was generally good, but knowledge of cessation was poor. Factors independently associated with assessing smoking status among all women were: employer service type (p = 0.025); cessation knowledge score (p = 0.011); and disagreeing with the statement that giving advice is not worth it given the low level of success (p = 0.011).

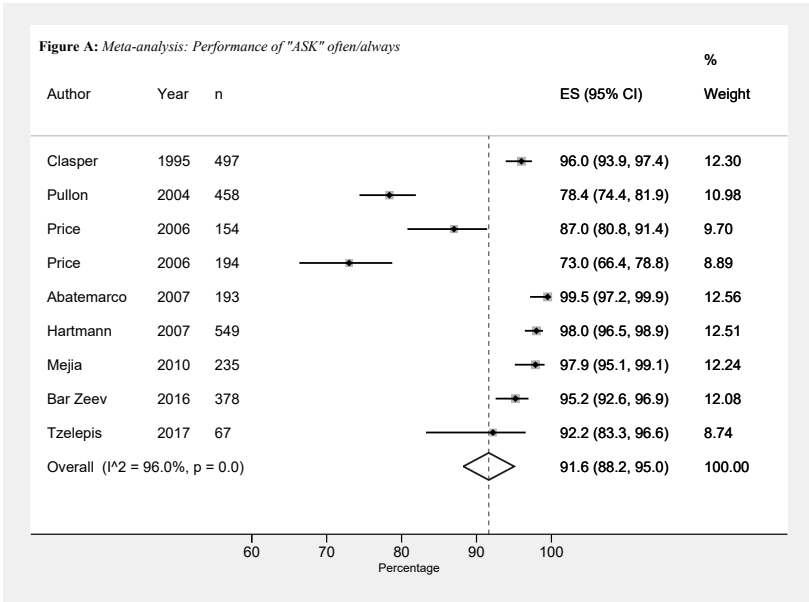
			reported assessment of smoking. Optimal and assessment of smoking status.							
Passey (2015) Australia	Pregnant Women	High Risk-women Aboriginal and Torres Strait Islander	Provision of antenatal smoking cessation support: A survey with pregnant Aboriginal and Torres Strait Islander women.	X	X		X			Despite most pregnant women who smoke reporting advice and support to quit, the persisting high prevalence of smoking suggests that this support is insufficient to overcome the many factors pushing women to smoke.
Passey (2014) Australia	Health Providers (AHW, Midwives or Nurses, Doctors)	High Risk-women High risk: Aboriginal and Torres Strait Islander	Supporting pregnant Aboriginal and Torres Strait Islander women to quit smoking: views of antenatal care providers and pregnant indigenous women.			NA*				Current smokers (n = 121) were less positive about the potential effectiveness of most of the 12 strategies than the providers (n = 127). For example, family support was considered helpful by 64 % of smokers and 91 % of providers; between 56 and 62 % of smokers considered advice and support from midwives, doctors or Aboriginal Health Workers likely to be helpful, compared to 85-90 % of providers. Rewards for quitting were considered helpful by 63 % of smokers and 56 % of providers, with smokers rating them more highly and providers rating them lower, than most other strategies. Quitline was least popular for both.
Price (2006) USA	Health Providers (Nurse-Midwives)	Low risk	Perceptions and Use of Smoking Cessation in Nurse-Midwives' Practice.	X	X	X	X	X	X	Few nurse-midwives identified barriers to counselling pregnant patients who smoked, but the most common were lack of time (14%) and not knowing where to send pregnant smokers for treatment (14%). Most respondents believed that nicotine replacement therapy (NRT) would be most likely to reduce the number of pregnant smokers (74%), yet few (26%) were confident in their ability to prescribe/recommend nicotine replacement therapy. Respondents more likely to use 5 A's can be characterized as the following: had higher efficacy expectations in their ability to communicate issues about the 5 A's and had higher outcome expectations regarding the effects of using the 5 A's.
Price (2006) USA	Health Providers (Obstetricians, Gynaecologists)	Low risk	Obstetricians and gynaecologists' perceptions and use of nicotine replacement therapy.	X	X	X	X	X	X	The majority did not prescribe NRT possibly because few respondents received cigarette smoking cessation training in medical school or their residencies. Significant revisions in professional training and more continuing medical education are needed regarding smoking cessation and use of NRT.
Pullon (2004) NZ	Health Providers (GPs Practicing Obstetrics, Midwives)	Low risk	Smoking cessation and nicotine replacement therapy in current primary maternity care.	X	X				X	Only about half of the health professional gave smoking cessation advice to most pregnant women who smoked. They were uncertain about the safety of NRT use in pregnant and breastfeeding women. Most respondents requested more information about NRT use.
Roske (2009) Germany	Health Providers (Midwives, Gynaecologists, Paediatrician)	Low risk	Smoking cessation counselling for pregnant and postpartum women among midwives, gynaecologists and paediatricians in Germany.	X	X		X			Depending on profession, 90 % to 100 % see smoking cessation counselling as their assignment, 17 % to 80 % screen for, 48 % to 90 % document smoking status, and 55 % to 76 % offer brief or extensive counselling. 61 % to 87 % consider training to enhance their knowledge and/or counselling skills necessary. The compliance of providers with the necessity to give support in smoking cessation is very high. However, the status of cessation counselling does not sufficiently correspond to the evidence based requirements.
Solberg (2010)	Pregnant Women	Low risk	Disparities in tobacco cessation medication orders				X		X	32,733 current users of tobacco, 18,047 of whom had both health insurance and pharmacy claims data available. After adjustment, 15.4% overall had received an order for cessation

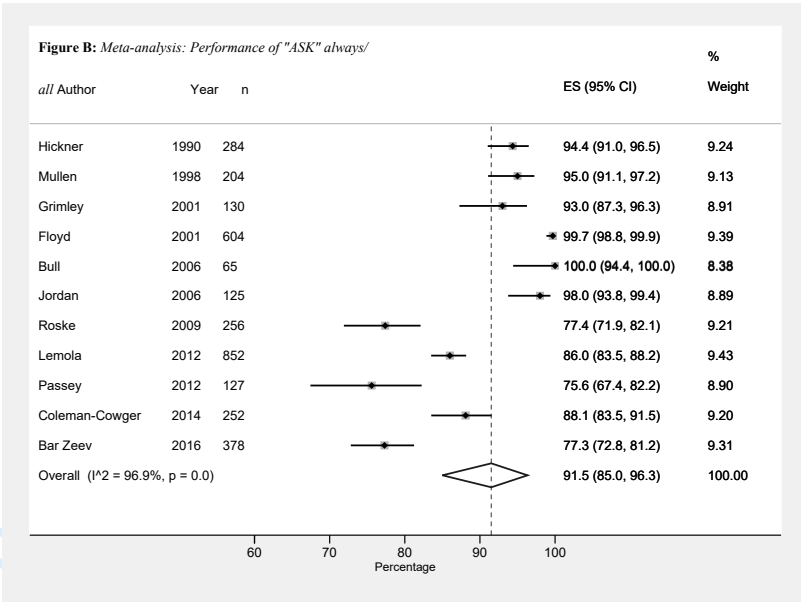
USA			and fills among special populations.						medications during this year, but only 78% had filled it. Groups receiving fewer orders than their comparison groups were aged 18-34 years or older than 65 years, men, pregnant women, Asians and Hispanics, and those with non-English-language preference, on Medicaid, or with fewer visits. The same groups were less likely to fill that prescription, except patients with non-English preference or Medicaid. There are disparities in both the receipt of cessation medication orders and the likelihood of filling them for some special populations. The causes are likely to be complex, but this information provides a starting point for learning to improve this problem.
Tappin (2010) UK	NA	Low risk	To establish a denominator for pregnant smokers in Scotland and describe the proportion who are referred to specialist services, engage in one-to-one counselling, set a quit date and quit 4 weeks later.	X			X		Poor smoking cessation outcomes are a product of current limitations to identification, referral, engagement and treatment. Carbon monoxide breath testing can bypass this difficulty of patient providing faulty information.
Thyrian (2006) Germany	Health Providers (Midwives)	Low risk	To establish a denominator for pregnant smokers in Scotland and describe the proportion who are referred to specialist services, engage in one-to-one counselling, set a quit date and quit 4 weeks later.	X	X	X			Smoking and exposure to environmental tobacco smoke are seen as prominent health threats that midwives reported they addressed routinely, including giving advice to stop smoking.
Tong (2008) USA	Pregnant Women	Low risk	Investigate the attitudes of midwives to counselling women about their smoking behaviour during pregnancy and post-partum.					X	Almost all women reported that their prenatal care provider asked if they smoked, but only 56.7% reported that a provider counselled them to quit smoking. Only 11.5% of women who smoked in late pregnancy used a cessation method, including self-help materials (6.3%); medications (3.9%); face-to-face counselling (1.7%); telephone-based counselling (1.5%); Internet-based counselling (1.3%); and a class or program (1.0%).
Tran (2010) USA	Pregnant Women	Low risk	To explore racial/ethnic disparities in the receipt of optimal smoking cessation counselling during prenatal care.	X	X	X			Of 594 first trimester pregnant smokers, the majority were asked and advised about smoking by a prenatal care provider. However, a substantial proportion of women did not receive assistance to quit and only 42.2% received all three steps. Significant racial/ethnic variations were found only in the Assist step. Compared to non-Hispanic (NH) White women, NH American Indian women had lower odds of receiving all three steps. In contrast, NH Black women had increased odds of receiving all three steps. We conclude that there is a need for prenatal care providers to address tobacco use, especially to Assist quitting, with all pregnant smokers.
Tzelepis (2017) Australia	Health Providers (AHW or Aboriginal Health Education Officers, Child	High Risk-women Aboriginal	To examine Aboriginal antenatal and postnatal staff confidence, perceived role and delivery of smoking cessation care to Aboriginal women and characteristics	X		X	X	X	Most staff reported they assessed clients' smoking status most or all of the time (92.2%). However, only a minority reported they offered a Quitline referral (42.2%), provided follow-up support (28.6%) or provided nicotine replacement therapy (4.7%) to most or all clients who smoked. Few staff felt confident in motivating clients to quit smoking (19.7%) and advising clients about using nicotine replacement therapy (15.6%). Staff confident with talking to clients about how smoking affected their health had significantly higher odds of offering a Quitline referral and quitting assistance to clients who smoke.

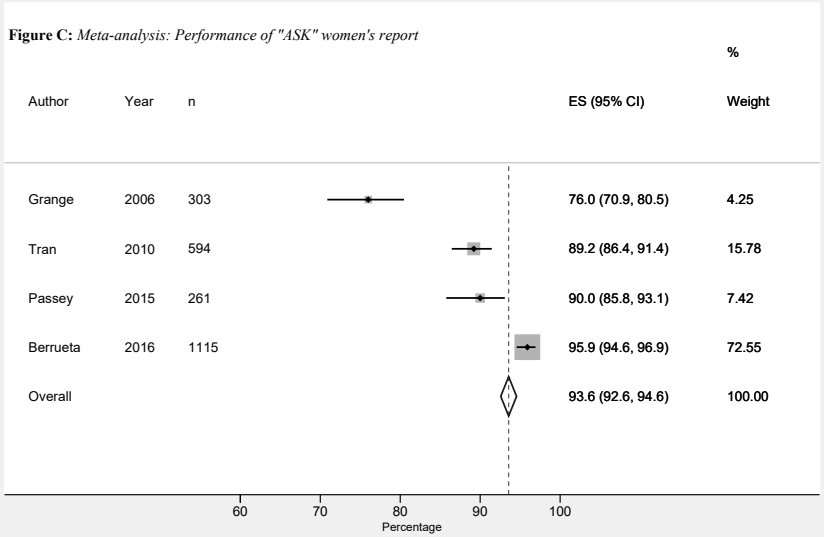
	Health Nurses, & Midwives)		associated with provision of such care.								
Walsh (1995) Australia	Health Providers (Medical Directors & Nursing Directors)	Low risk	To assess the smoking cessation practices of Australian public antenatal clinics.		X		X	X		Smoking advice was rated an essential activity at the first antenatal visit by 69% of responding directors. Nonetheless, only 12% of clinics indicated they offered relevant training and 4% reported written policies. Results also indicate senior staff may have suboptimal levels of awareness of smoking risks. Clinics used a narrow array of strategies to promote cessation. Almost one-third of directors said they advised smokers to cut down rather than stop smoking completely.
Zapka (2000) USA	Health Providers (Physician, Nurse-Practitioner or Midwife, RN, Nutritionists, Nutrition Assistant)	Low risk	Assess providers' performance of smoking cessation counselling steps with low-income pregnant and postpartum women receiving care at community health centres.	X	X	X	X	X	X	Providers in obstetric clinics had the highest scores and those in paediatric clinics had the lowest scores. Nurse practitioners and nutritionists had higher scores than other providers. Clinic type, greater smoking-related knowledge, older age, and perception of smoking cessation as a priority were independently related to better counselling performance. Low scores for performance of steps beyond assessment and advice indicate a need for emphasis on the assistance and follow-up steps of national guidelines. Providers' own commitment to helping mothers stop smoking was important.

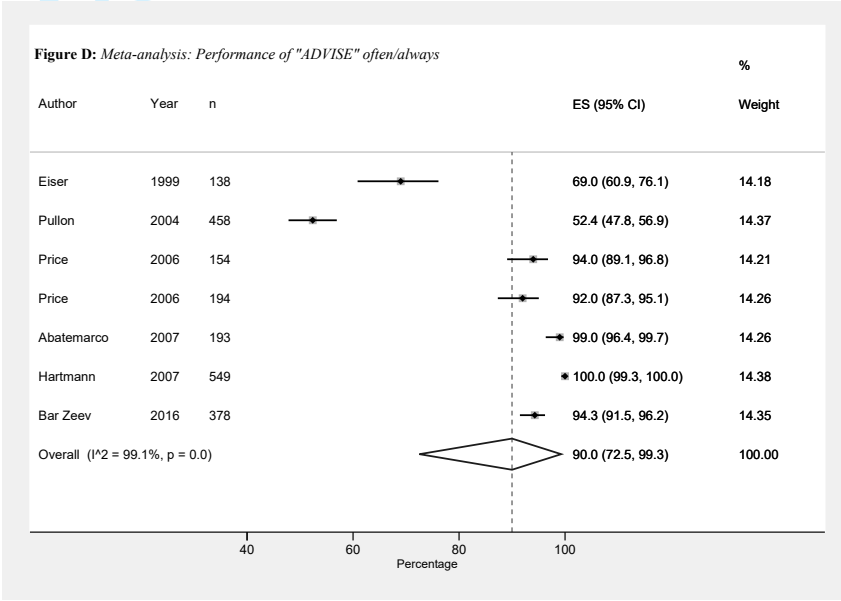
NA – Not applicable to study or not described

Forest Plots 1-17









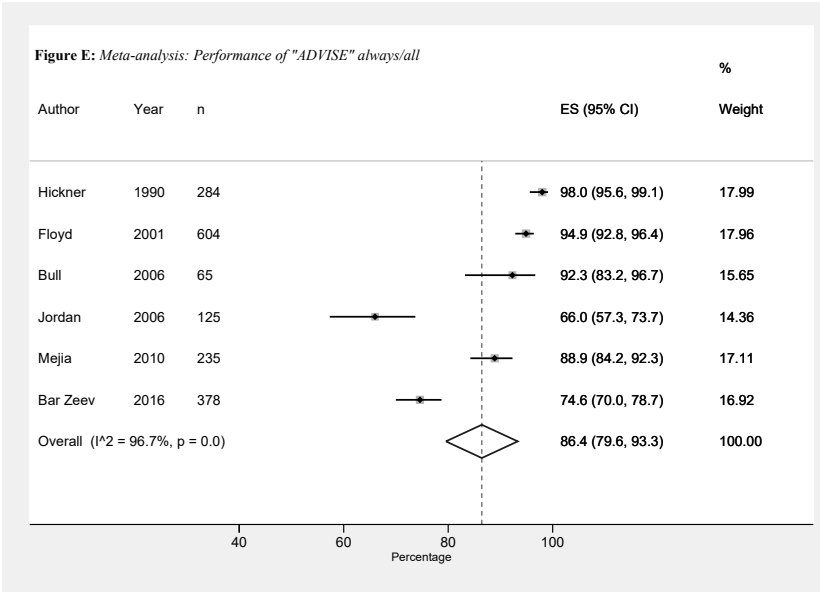


Figure E: *Meta-analysis: Performance of "ADVISE" always/all*

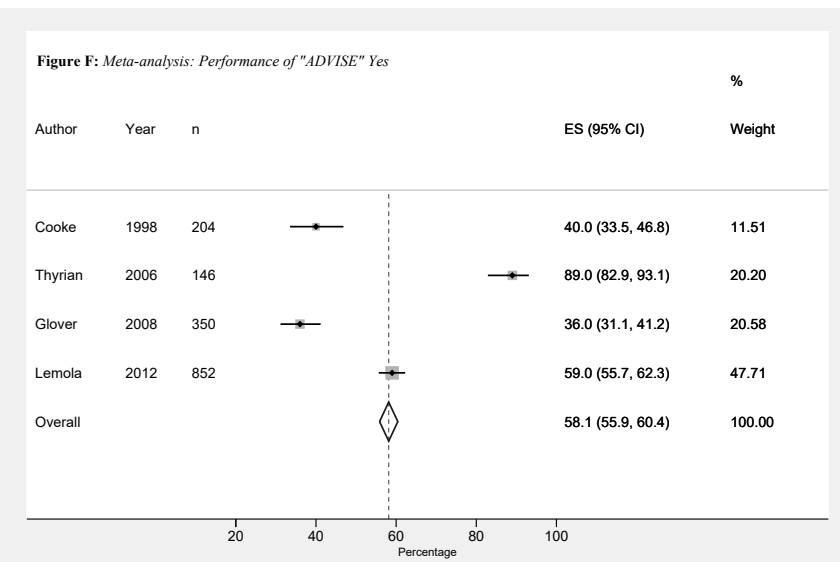


Figure F: *Meta-analysis: Performance of "ADVISE" Yes*

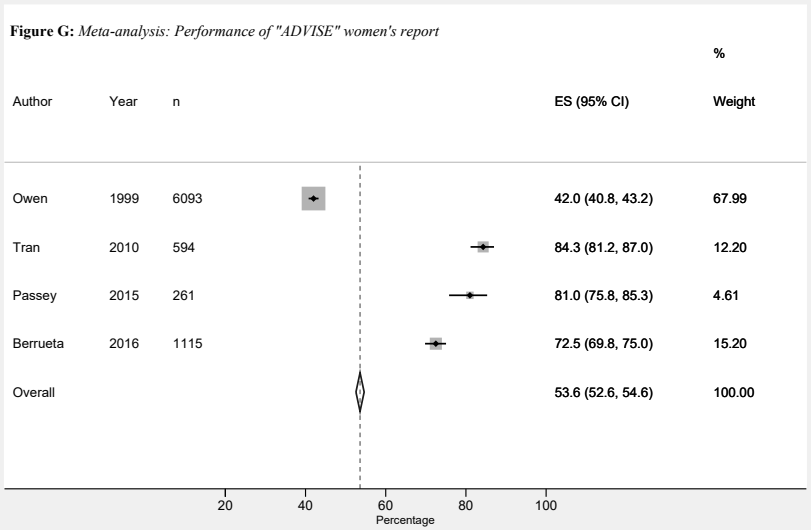


Figure G: *Meta-analysis: Performance of "ADVISE" women's report*

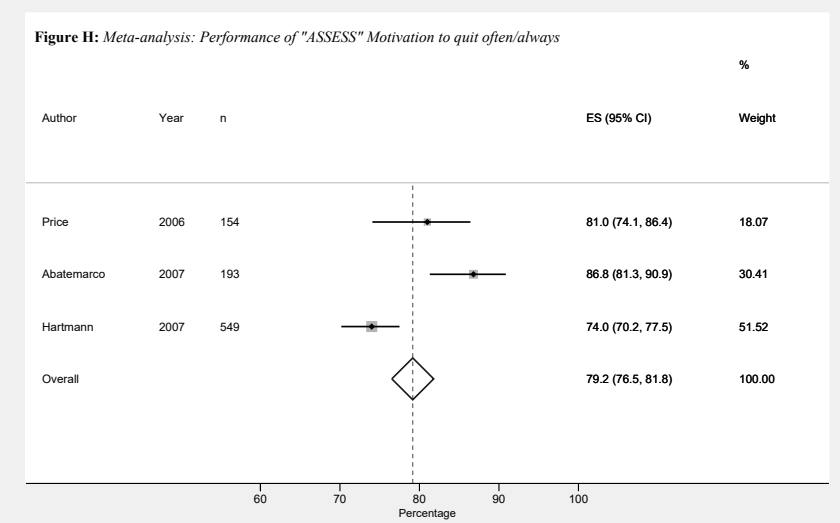


Figure H: *Meta-analysis: Performance of "ASSESS" Motivation to quit often/always*

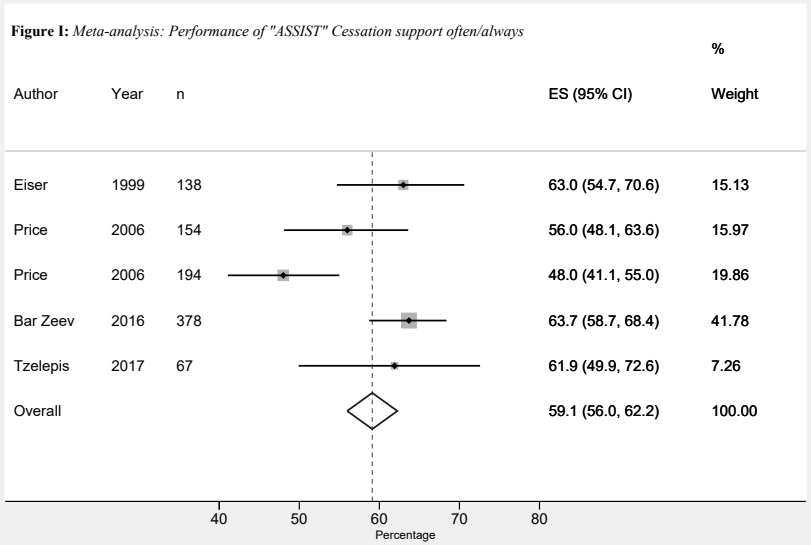


Figure I: *Meta-analysis: Performance of "ASSIST" Cessation support often/always*

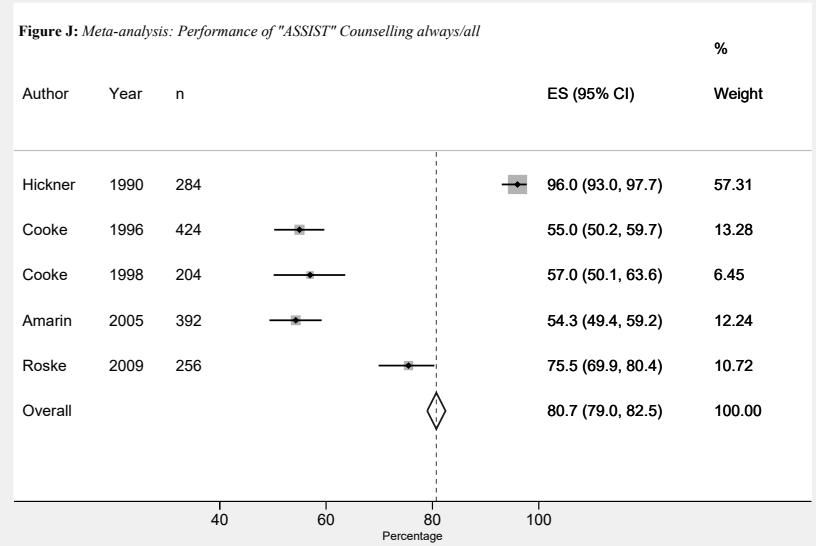


Figure J: *Meta-analysis: Performance of "ASSIST" Counselling always/all*

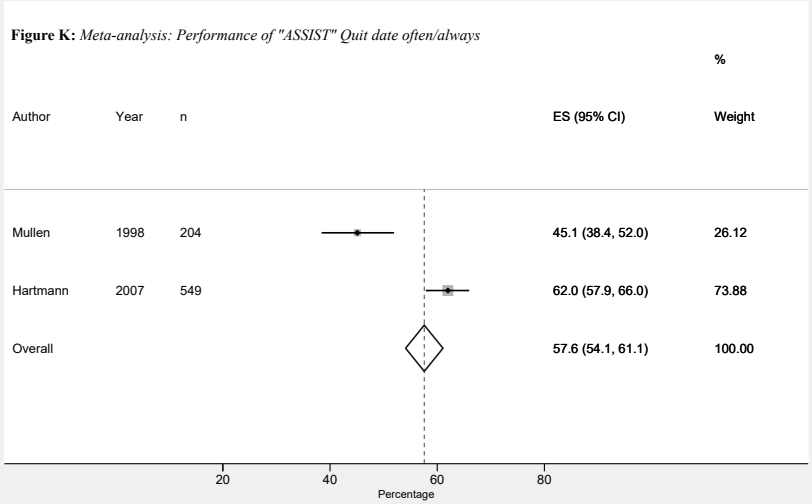


Figure K: *Meta-analysis: Performance of "ASSIST" Quit date often/always*

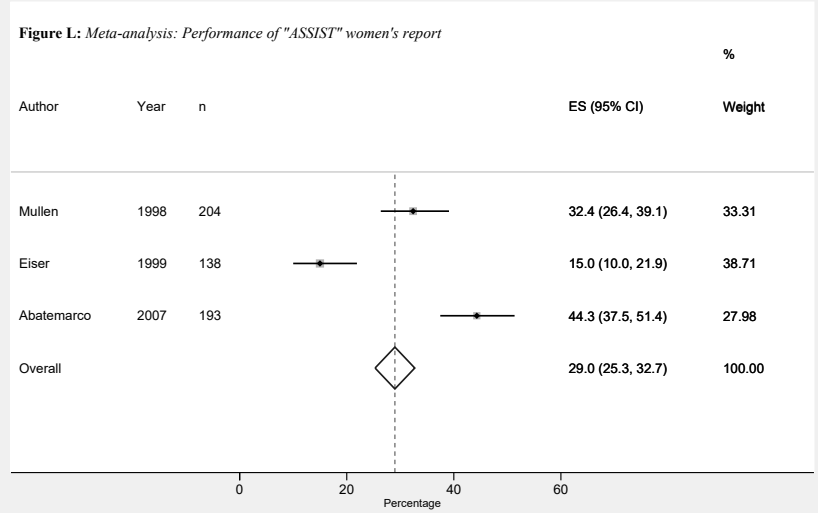
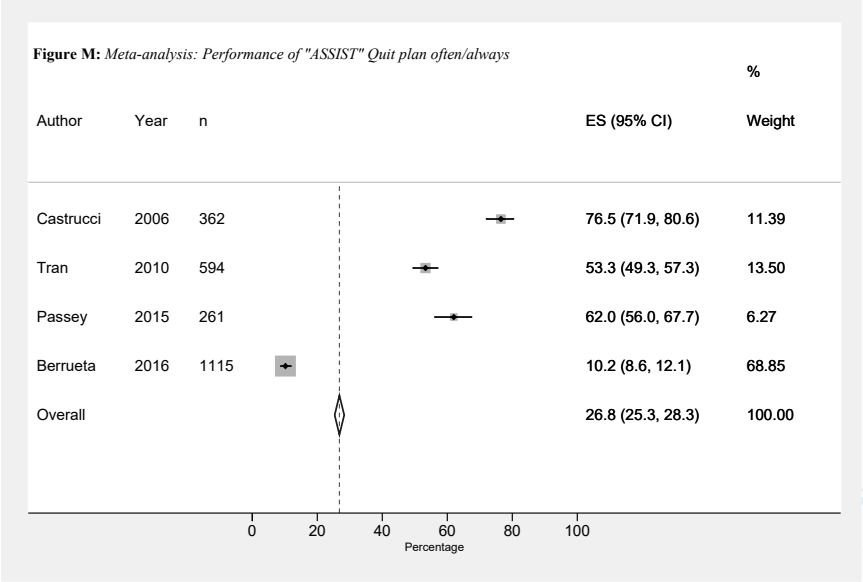
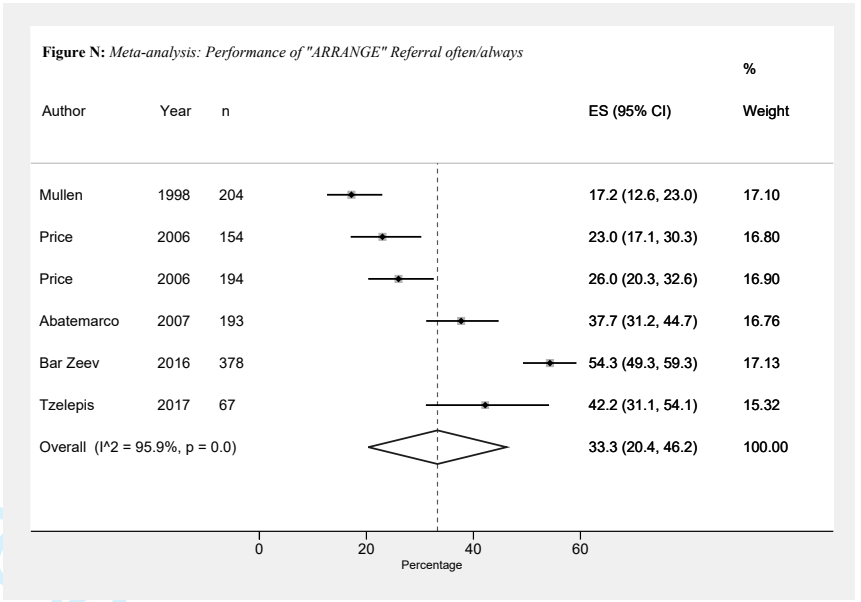
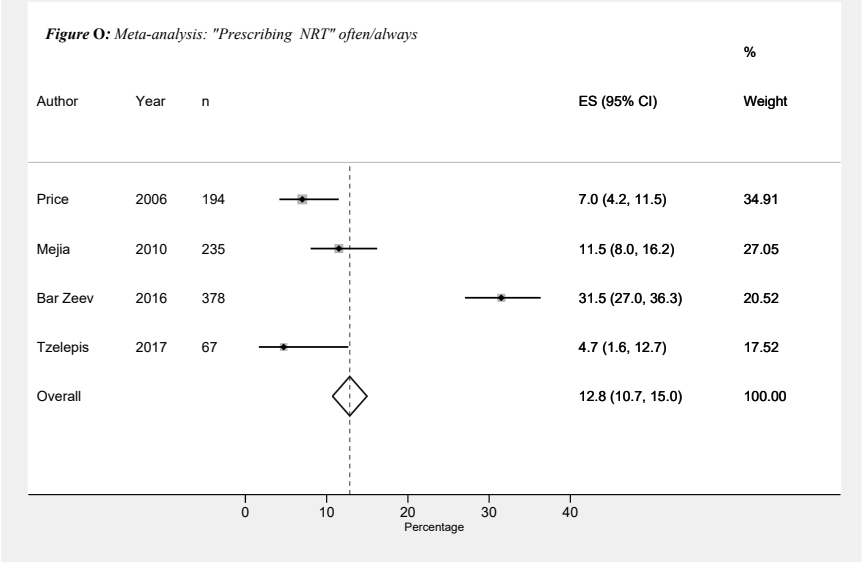
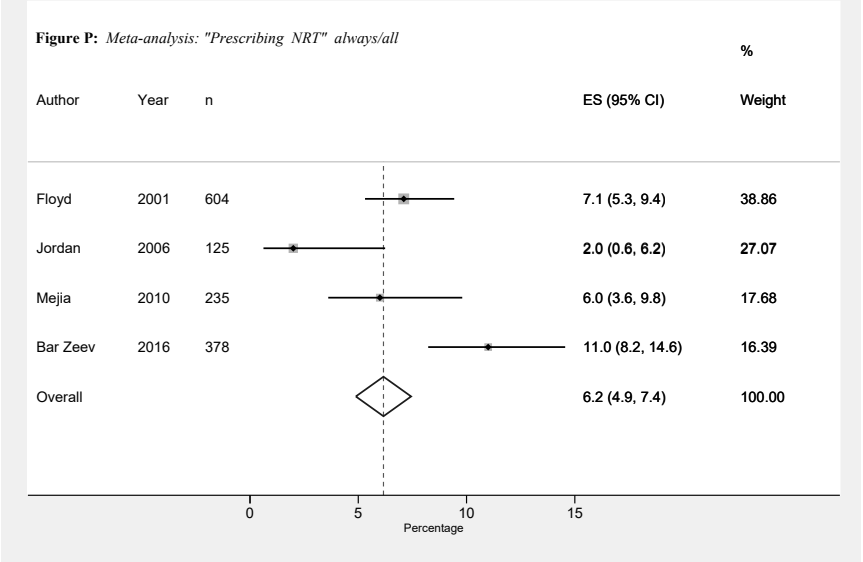


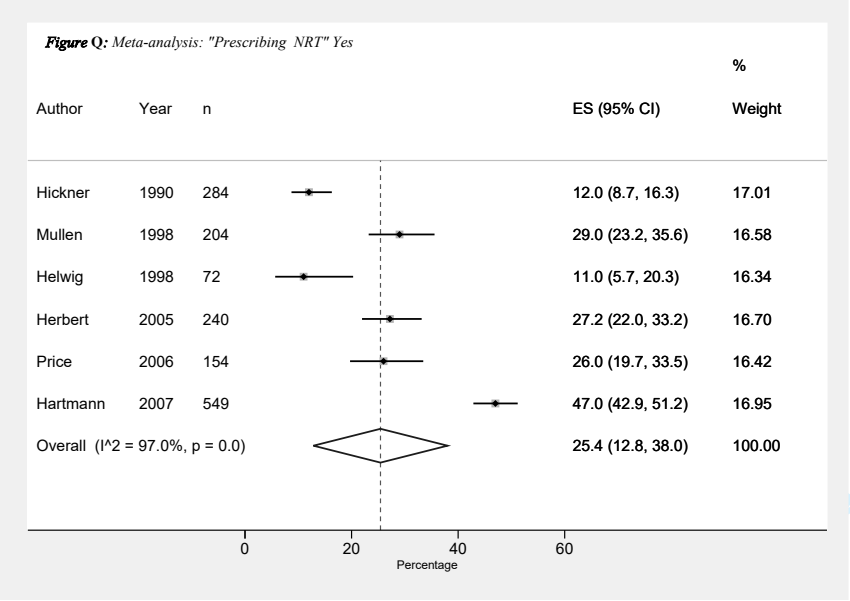
Figure L: *Meta-analysis: Performance of "ASSIST" women's report*











Reporting checklist for meta-analysis of observational studies.

Based on the MOOSE guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the MOOSE reporting guidelines, and cite them as:

Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, Moher D, Becker BJ, Sipe TA, Thacker SB. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. JAMA. 2000; 283(15):2008-2012.

	Reporting Item	Page Number
#1	Identify the study as a meta-analysis of observational research	NA
#2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number (From PRISMA checklist)	2-3
#3a	Problem definition	7
#3b	Hypothesis statement	NA
#3c	Description of study outcomes	11-16
#3d	Type of exposure or intervention used	NA
#3e	Type of study designs used	9, 11

	#3f	Study population	12
Search strategy	#4a	Qualifications of searchers (eg, librarians and investigators)	8
	#4b	Search strategy, including time period included in the synthesis and keywords	7
	#4c	Effort to include all available studies, including contact with authors	NA
	#4d	Databases and registries searched	7
	#4e	Search software used, name and version, including special features used (eg, explosion)	7
	#4f	Use of hand searching (eg, reference lists of obtained articles)	7-8
	#4g	List of citations located and those excluded, including justification	7-8
	#4h	Method of addressing articles published in languages other than English	NA
	#4i	Method of handling abstracts and unpublished studies	8
	#4j	Description of any contact with authors	NA
	#5a	Description of relevance or appropriateness of studies gathered for assessing the hypothesis to be tested	9-10
	#5b	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	8
	#5c	Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	8-9
	#5d	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	NA
	#5e	Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results	9
	#5f	Assessment of heterogeneity	10
	#5g	Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	10

#5h	Provision of appropriate tables and graphics	11
#6a	Graphic summarizing individual study estimates and overall estimate	NA
#6b	Table giving descriptive information for each study included	8
#6c	Results of sensitivity testing (eg, subgroup analysis)	10-11
#6d	Indication of statistical uncertainty of findings	11
#7a	Quantitative assessment of bias (eg. publication bias)	NA
#7b	Justification for exclusion (eg, exclusion of non–English-language citations)	NA
#7c	Assessment of quality of included studies	18
#8a	Consideration of alternative explanations for observed results	21
#8b	Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	21
#8c	Guidelines for future research	21
#8d	Disclosure of funding source	22

BMJ Open

What components of smoking cessation care during pregnancy are implemented by health providers? a systematic review and meta-analysis

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What components of smoking cessation care during pregnancy are implemented by health providers? a systematic review and meta-analysis

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Abstract

Background Pregnancy is an opportunity for health providers to support women to stop smoking.

Objectives Identify the pooled prevalence for health providers in providing components of smoking cessation care to women who smoke during pregnancy.

Design A systematic review synthesising original articles that reported on 1) prevalence of health providers' performing the 5As ('Ask', 'Advise', 'Assess', 'Assist', 'Arrange'), prescribing nicotine replacement therapy (NRT), and 2) factors associated with smoking cessation care.

Data Sources MEDLINE, EMBASE, CINAHL and PsycINFO databases searched using "smoking", "pregnancy" and "health provider practices".

Eligibility criteria for selecting studies Studies included any design except interventions (self-report, audit, observed consultations, women's reports), in English, with no date restriction, up to June 2017.

Participants Health providers of any profession

Data extraction, appraisal and analysis Data were extracted, then appraised with the Hawker tool. Meta-analyses pooled percentages for performing each of the 5As and prescribing NRT, using e.g., 'often/always' and 'always/all'. Meta-regressions were performed of 5As for 'often/always'.

Results Of 3933 papers, 54 were included (n =29,225 participants): 33 for meta-analysis. Health providers included general practitioners, obstetricians, midwives and others from 10

countries. Pooled percentages of studies reporting practices 'often/always' were: 'Ask' (*n*=9) 91.6% (95%CI:88.2,95); 'Advise' (*n*=7) 90% (CI:72.5,99.3), 'Assess' (*n*=3) 79.2% (CI:76.5,81.8), 'Assist (cessation support)' (*n*=5) 59.1% (CI:56, 62.2), 'Arrange (referral)' (*n*=6) 33.3% (CI:20.4,46.2), and 'prescribing NRT' (n=6) 25.4% (CI:12.8,38). Heterogeneity (I^2) was 95.9%-99.1%. Meta-regressions for 'Arrange' were significant for year (p=0.013) and country (p=0.037).

Conclusions Health providers 'Ask', 'Advise' and 'Assess' most pregnant women about smoking. 'Assist', 'Arrange' and 'prescribing NRT' are reported at lower rates: strategies to improve these should be considered.

Registration PROSPERO 2015:CRD42015029989.

Strengths and limitations of this study

- Comprehensive meta-analysis and meta-regression of health providers implementation of the 5As combining like measures for smoking cessation care.
- Fifty four studies from 7 high-income and three low-middle income countries includes disciplines of medicine, nursing, and allied health.
- High heterogeneity in the meta-analyses was unexplained by the meta-regressions, except for 'Arrange referral-often/always' which was related to year, and country
- Quality ratings of some papers were poor - findings from these studies may be less reliable.
- Review aids in determining which components of smoking cessation care are less reliably implemented in pregnancy.

Keywords: smoking, health care providers, smoking cessation, maternal health, pregnancy

Word count: 4724

Introduction

Smoking during pregnancy carries high risks for mother and child, including obstetric complications for the mother,[1] and for the baby, premature birth, growth restriction, low birth weight, still-birth, and congenital defects.[1,2] Longer-term effects on the child include respiratory illnesses, learning and behavioral problems, and increased risks of chronic diseases,[1,2] and of taking up smoking in adolescence.[3]

Smoking during pregnancy remains a prevalent behaviour in many countries, with estimated smoking prevalence rates ranging from 0.2% to 38.4%.[4] Pregnancy is a time when women are more likely to be motivated to stop smoking.[5] However, disadvantaged women, including women from minority and Indigenous populations where there is a high prevalence of community smoking, also smoke at higher rates and are less likely to try to stop smoking, or succeed than more advantaged women among whom smoking prevalence is lower.[6, 7] Also, less likely to stop smoking are women who are: of low socio-economic status,[6] multi-parous,[6] adolescents,[8] partnered by smokers,[6] and those experiencing: alcohol or substance use,[8] depression,[9] life stressors,[10,11] or intimate partner violence.[12] Women frequently reduce tobacco consumption when discovering they are pregnant,[11,13] indicating a consciousness about the risks, but may be less likely to abstain than non-pregnant women.[14] Pregnant women report a lack of support for smoking cessation, and that health providers (HP) consider cutting down to be acceptable.[15,16]

HPs in primary care have a critical role to offer advice and support women to stop smoking during pregnancy.[17] Ideally smoking cessation care (SCC) includes counselling and pharmacotherapy – most successful when combined.[17,18] In pregnancy, the effective use of

pharmacotherapy is less certain, and clinical guidelines vary across and within different countries.[17] In pregnancy, only nicotine replacement therapy (NRT) is recommended, but not consistently advised for use in pregnancy in all countries,[17,19] for example NRT is not advised in the USA for use in pregnancy,[20] but it is more routinely prescribed in the UK.[21] Clinical guidelines in the UK, Australia, New Zealand and Canada recommend that a woman should initially endeavour to quit without medication, but if she cannot, NRT can be prescribed.[17 22-25]

The 5As ('Ask (about smoking)', 'Advise (to quit)', 'Assess (motivation and/or dependence)', 'Assist (with cessation)', and 'Arrange (follow-up or referral)') has been adopted in many countries as a strategy for HPs to deliver all the important components of SCC.[26] Several studies have examined the performance of the 5As in pregnancy. Two reviews summarised the literature . Okoli et al's integrative review reported on HP performance of components of the 5As. While authors reported more than 50% of HPs Ask and Advise about smoking, and less than 50% Assess, Assist or Arrange (referral or follow-up), it is unclear how these estimates were calculated. This is an important limitation considering the variable ways studies collect data and report them,.[27] Baxter et al's qualitative systematic review, on the factors that influenced uptake of interventions by pregnant women, included studies on HP and women's reports of their receipt of SCC, and noted variation between HPs for recording smoking status and advice.[28] As neither review included a meta-analysis, it is timely and important from the point of view of rigour to have a definitive evaluation of HP practices, and furthermore to accurately inform recommendations to guide strategies to improve SCC. An urgent need for research to increase the uptake of smoking cessation interventions, and improve quit rates in pregnant women who smoke has been identified by Siddiqi and Mdege [29]

The objective of this systematic review was to summarise published empirical research of eligible studies from a range of HPs who consult with pregnant women who smoke, and synthesise findings with meta-analyses where feasible. The primary aim was to determine the prevalence of the components of SCC that were being practiced, including the 5As, prescribing NRT, and related behaviour change techniques (BCTs - observable and replicable components designed to change behaviour),[30] thus determine which aspects of SCC need improvement. A second aim was to examine which factors were associated with delivery of the 5As, and NRT prescribing i.e., HP types, country, year, and pregnant women in high-risk populations. We also examined data about knowledge and attitudes of the HPs to inform their practices.

Methods

Data were identified by searches of MEDLINE, EMBASE, CINAHL and PsycINFO, and reference lists from relevant articles. Where possible, search terms were matched to MESH or database specific subject headings, and used as keywords. Search terms included (Supplementary File Table 1): pregnancy (e.g., perinatal care, mother), smoking (e.g., nicotine dependence, smoking cessation), health professional (e.g., general practitioner, midwife), and attitudes or practices (e.g., capacity, belief). Searches were performed in September 2015; additional studies included until June 2017.

Inclusion criteria: peer-reviewed full papers on SCC to pregnant smokers by any HP in any setting, restricted to English language, with no date restrictions. Quantitative studies and/or quantitative data from mixed methods studies with any study design

were included, comprising self-reported provision of SCC by HPs, reported receipt of SCC by pregnant women, or other indicators e.g., chart audit or audio-recordings of consultations. For this review, SCC was based on the 5As: asking about smoking, advising about quitting, assessing motivation to stop smoking or nicotine dependence, assisting to quit, and arranging follow up or referral.[26] In addition, we included papers reporting HP knowledge, attitudes, and other practices e.g., advising about relapse and smoke-free homes, discussing psychosocial contexts of smoking, involving family members or partners, prescribing NRT, and other BCTs (e.g., setting a quit date, making a quit plan, providing resources and self-help materials, aiding social support, encouraging smoke-free environments, and monitoring carbon monoxide readings).[31,32] Exclusion criteria: intervention studies and studies in non-peer-reviewed literature; studies on pre-conceptual and post-natal care. Additionally, 10 papers that did not have a main focus on the review topic and/or reported minimal data about the topic such as one line or one data item in a full paper, were excluded (list available from authors on request). The review was registered with PROSPERO 2015: CRD42015029989. We used the MOOSE checklist when writing our report.[33]

Two researchers (LT – behavioural scientist, YB - physician) independently screened titles, abstracts, and then full papers and applied the inclusion criteria to determine eligibility. Discrepancies were resolved by consensus, with a third researcher (GSG) acting as adjudicator, when agreement was not reached. Studies that met all criteria were retained for full review. One researcher completed data extraction (LS) with a second (YB) extracting 20% of articles, then results compared. A summary table (Supplementary File Table 2) was developed from this data (GRG, GSG). The characteristics of each study were examined including aims, setting, country, sample characteristics, study focus (HP or women), HP type,

study design and method, measures, extracted results for each of the 5As, prescription of NRT, and whether the study addressed the provision of BCTs, and if so a description of the BCTs (e.g., setting a quit date, increasing self-efficacy, monitoring carbon monoxide reading, validating abstinence).

As the studies overall were of all types of design, a quality assessment of the quantitative and mixed studies was carried out using Hawker et al's tool for reviewing disparate data systematically.[34] This was chosen in the absence on any consensus on the best tool, as we were including quantitative and mixed method studies in the review. LS rated all studies using the tool (20% double-rated by YB). Studies were included irrespective of quality.

Quantitative data were presented as percentages and counts were possible, and meta-analyses made for estimates of each of the 5As of SCC provision, and prescribing NRT. A narrative analysis summarises other studies or outcomes, including BCTs where reported. For each outcome measure we looked at the specific measurements across studies to determine whether it was clinically appropriate to group them together i.e., Ask, Advise, Assess (motivation to quit, nicotine dependence), Assist (cessation support, quit date, quit plan, prescribe NRT), Arrange (follow up, referral). To achieve this, we considered both the data collection method (cross-sectional survey; audit of patients' medical records; audio-recording of consultation; women's report through survey or interview) and the measure itself that was used (e.g., Likert scale, or a dichotomous Yes/No response, and so forth). General principles applied were as followed (explained in more detail in Supplementary Text 1):

- **'Often/Always'** included survey measures reflecting asking 'often' and 'always', 'usually and always'; and/or 'most of the time' and 'all of the time'). The combined answers in Likert scales were dichotomised for analysis.
- **'Always/all'** included in this analysis was the proportion of HPs answering 'always' or 'all of the time', if a Likert scale was used, or the proportion answering 'Yes' if a dichotomous question was used: either asking 'do you ask all of your patients?' or 'do you ask your patients always?' Answers reporting on 'Asking' more than 75% of their patients were considered as 'Yes' for these analyses.
- **'Yes'** where a survey asked the HP a dichotomous question for example 'Do you advise? Yes/No' were grouped separately as "Advise - Yes"
- Papers describing women's reports were analysed separately from those describing health provider reports

All statistical analyses were programmed using Stata v13.1 (StataCorp LP, College Station, TX, USA). Meta-analyses were performed to examine the performance of each of the 5As, including prescribing NRT, as above. Stata program *Metaprop* was used to pool dichotomized responses for each of the 5As. If more than 5 studies were pooled, random effects modelling (DerSimonian and Laird's method) was used to account for differences in underlying estimates due to study population and design; heterogeneity (I^2) was measured for each reporting type. If the number of studies was low (≤5), fixed effects modelling was used as the between-studies variance (tau-squared), and therefore the mean of the underlying random distribution cannot be estimated with precision; heterogeneity is not presented.[35] Where required, in order to include studies where the percent reporting the outcome was 100%, the Freeman-Tukey Double Arcsine Transformation method was used to stabilize the

variances prior to pooling. Pooled estimates for study outcomes were split by response, and also by HP type. Significance was set as α=0.05 a priori.

For the 'often/always' responses to Ask, Advise, Assist, Arrange, including prescribing NRT, meta-regression (Stata program *Metareg*) was used to examine whether some of the heterogeneity seen in the proportions reported for each study could be explained by HP type (e.g. midwife, general practitioners (GP), obstreticians (OBS), or mixed groups of HPs), high-risk population versus not (e.g., women in low socio-economic groups, Indigenous women, or with mental health diagnoses), country (USA, Europe, Australia/New Zealand, or Other), or year of publication (1990-2017). P-value, changes in heterogeneity (I^2 residual), changes in between study variance (τ^2), and proportion of between-study variance explained by predictor (adjusted R^2) were reported. For year, the linearity of proportion over time was examined, and if a non-linear trend was seen then the meta-regression was not performed. Meta-regressions for the other meta-analyses were not performed.

An analysis of agreement of quality-rating coders was performed. Weighted kappa (ordinal multi-rater - quadratic weighted Kappa) was used to compare the rating of 9 quality study criteria for 15 studies; each criteria was scored on a 5 point scale (Very poor, Poor, Fair, Good, Very Good). Mean (SD) ratings were calculated for each criteria for each rater. Kappa and weighted kappa estimates were interpreted using cut-off criteria specified by Altman.[36] Strength of agreement was < 0.20 Poor; 0.21 - 0.40 Fair; 0.41 - 0.60 Moderate; 0.61 - 0.80 Good; 0.81 - 1.00 Very Good.

Patient and Public Involvement

As a systematic review we did not directly involve any patients or public in the study. However the review was informed by patient and health provider needs. Participants from previous studies reported to us that they were not receiving comprehensive smoking cessation care during pregnancy from their health providers,[16] nor were health providers in a previous study reporting they delivered comprehensive smoking cessation care.[37] This review was responsive to global knowledge about the receipt and delivery of smoking cessation care in pregnancy being a gap in the literature.

Results

Of the 3933 studies found, 54 papers met the inclusion criteria for quantitative review. See Prisma Flow Chart for included studies (Figure 1).

A total of 54 studies were included in this analysis.[37-90] Study details including author, country, study focus (HP, women, or both), population and risk category (high/low), study aims, inclusion of 5As, and summary of results are presented in Supplementary File Table 2. Of these studies, approximately 90% were quantitative (n = 49), [38-43,45,48-64,66-75,77-91] and approximately 10% (n = 5) utilized mixed methods, containing both quantitative and qualitative aspects.[44,46,47,65,76] The included studies used the following study methods: survey (n = 48),[38-45,48-62,64-67,69-81,84-91] audio-recordings (n = 2),[46,47] audit (*n* = 2),[82,83] audit with interview (n = 1),[63] and observational (n = 1).[68]

Study location included seven high income countries (United States of America,[38,45,49,54,57-59,61,65,71,78,79,86] United Kingdom,[44,48,52,60,74] Australia,[51,75,76,87,90,91] Germany,[81,84] Switzerland,[66] New Zealand,[55,56,80] France, [46]) and three low to middle income countries (Jordan, Argentina, and Urugauy).[28,32,59]

Included studies focused on either HPs (*n* = 39, 72%), [38,39,41,43,44,47-55,57-61,65,66,68-73,75,78-81,83,84,87-91] pregnant women (*n* = 12, 22%),[40,42,45,56,62,63,67,74,76,82,85,86] or both HPs and pregnant women (*n* = 3, 6%).[46,64,77] Studies encompassing HPs included obstetricians and gynaecologists (OBS) (*n* = 9, 21%),[39,49,53,54,57,65,71,73,79] midwives (*n* = 7, 17%),[38,41,51,52,64,72,84] general practitioners (GPs) (*n* = 3, 7%),[60,61,68] multiple professions (e.g., OBS, GPs, nurses, healthcare assistants; *n* = 21, 50%),[43,44,46-48,50,55,58,59,66,69,70,75,77,79-81,87,89-91] or did not report the profession (*n* = 1, 2%).[83]

Out of the 54 papers, information on Ask, Advise, Assess, Assist and Arrange (follow up/referral) was reported by approximately 68%, 70%, 28%, 63%, and 54% of studies, respectively. Few studies addressed all of the 5As combined (*n*=12, 22%). These reported that HPs rarely addressed all of the 5As, e.g. only 19.6% of respondents in Bar-Zeev et al's study of GPs and OBS performed all of the 5As 'often/always'.[91]

Only four studies (7%) addressed the provision of other BCTs in pregnancy. In one study, 31% of OBS advised women to set a quit date;[39] in a second study 29% of midwives suggesting quitting with an acquaintance;[52] 97% of women in a third sample reported they had not had their exhaled carbon monoxide tested,[56] and a fourth study reported which clinics used open-ended questions and problem solving.[89] Additionally, some studies (*n*=12, 22%), obtained information on or addressed a woman's psychosocial context for smoking e.g., family or partner's smoking status or involvement in quitting, a woman's social support, or her living environment e.g., a smoke free home or vehicle (*n*=3, 6%). Information regarding the use of resources was addressed in 20 studies (37%), i.e., providing pamphlets or recommending online programs. Advise about relapse was rarely addressed in the included literature (*n*=3, 6%); e.g. in one of the studies midwives reported they discussed with women how to avoid relapse.[52]

Twenty-nine papers of the 54 papers addressed NRT in some capacity. These included knowledge and training, attitudes to NRT, and prescribing of NRT. Papers addressing knowledge, attitudes and training in general (*n*=14, 26%) also reported on HP knowledge about whether NRT can be used in pregnancy, and HP confidence about their smoking cessation knowledge, awareness of smoking cessation guidelines, knowledge about the consequences of smoking for expectant mothers, and risks to their baby. The majority of HPs believed maternal smoking to be harmful to the fetus and/or the woman, with reports ranging from 90-100%. General knowledge about smoking in pregnancy varied (e.g., in Bonollo et al,[43] only 44-52% of US HPs of various types, had correct knowledge). In Mejia et al's study 75% of Argentinan physicians believed it was safe to smoke up to six cigarettes when pregnant.[69]

In addition, the above group of studies included aspects of smoking cessation training (i.e., whether training had been offered, engaged in, and if more training was needed). In general, HPs reported they had received limited training on smoking cessation care in pregnancy, and identified that they required more training.

Papers including information on NRT prescribing (*n*=14, 26%) reported on the frequency of considering to prescribe NRT, the frequency of recommendation of NRT, frequency of prescribing NRT, percentage of NRT scripts filled by women, percentage following FDA NRT prescription reccomendations, and the different NRT types prescribed (e.g., patches, gum, or inhalators). Overall findings suggested that HPs more often than not chose to not prescribe NRT to pregnant women who smoke, this was also supported by the meta-analysis below.

Attitudes and knowledge was associated with HP practices. In one Australian study, higher levels of knowledge about NRT were associated with greater likelihood of assessing

women's smoking status.[75] In another US study, OBS who perceived NRT as safe to use in pregnancy were 20 times more likely to prescribe NRT.[78] An Australian study determined that HP optimism, and confidence in counselling and/or prescribing NRT, and having sufficient time and resources were associated with a higher performance of all the 5As.[91]

Thirty-three studies were suitable for meta-analysis.[38,39,42,44,45,48,49,51,52,54-58,60,61,65,66,69,71,74-76,78,80,81,84,87,90,92] Seventeen meta-analyses were performed and associated forest plots constructed (see Supplementary File Forest Plot Figures 1 to 17). Figure 2 provides a visual comparison for pooled percentatges of selected categories of 'often/always'.

Overall the performance of 'Ask – often/always' (*n*=9) was 91.6% (95% CI 88.2%, 95%). Percentages for 'Ask – 'always/all'' (*n*=11) was similar at 91.5% (95%CI 85%, 96.3%). Percentages for 'Ask –Yes' (n=4, all by women's report) was slightly higher at 93.6% (95%CI 92.6%, 94.6%).

The performance of 'Advise – often/always' (*n* = 7) was 90% overall (95%CI 72.5%, 99.3%). Percentages for 'Advise – always/all' (*n* = 6) was 86.4% overall (95%CI 79.6%, 93.3%). Percentages for 'Advise – Yes' (HP report) (*n* = 4) was much lower at 58.1% overall (95%CI 55.9%, 60.4%). Percentages for 'Advise – women's report Yes' (*n* = 4) was similar at 53.6% overall (95%CI 52.6%, 54.6%). Percentages for 'Assess motivation to quit – often/always' (*n* = 3) was 79.2% overall (95%CI 76.5%, 81.8%).

Overall 34 manuscripts included a question about assisting. Some were generally asked about assisting the patient to quit, others specified a method of assisting such as counselling, setting a quit date, making a quit plan, and prescribing NRT. Those in the meta-analysis were as follows: 'Assist cessation support – often/always' (*n* =5) was 59.1% (95%CI 56%, 62.2%);

'Assist counselling – yes' (*n*=5) was higher at 80.7% (95%CI 79%, 82.5%); 'Assist quit plan – often/always' (*n*=2) was 57.6% (95%CI 54.1%, 61.1%); 'Assist quit date – often/always' (*n*=3) was low at 29% (95%CI 25.3%, 32.7%); 'Assist – women's report Yes' (*n*=4) was the lowest at 26.8% (95%CI 25.3%, 28.3%). The performance of 'Arrange referral – often/always' (n=6) was 33.3% overall (95%CI 20.4%, 46.2%). There was no analysable data on women's report for 'Arrange'.

'Prescribing NRT – Yes' was 25.4% (*n*=6) overall (95%CI 12.8%, 38%). 'Prescribing NRT – often/always' (*n*=4) however was very low at 12.8% overall (95%CI 10.7%, 15%). The performance of 'Prescribing NRT – always' (*n*=4) was the lowest at 6.2% overall (95%CI 4.9%, 7.4%). There was no analysable data on women's report of having been prescribed NRT. All of the studies in the meta-analysis for 'Prescribing NRT – Yes' were from the USA (Supplementary File Forest Plot Figure 17).

High heterogeneity (I^2 =95.9- 99.1%) was seen for: 'Ask – often/always'; 'Ask – always'; 'Advise – often/always'; 'NRT prescription'; 'Arrange referral – often/always'; thus indicating considerable diversity in study outcomes, methodology, or populations. A fixed effects model was used for the following outcomes due to low number of studies, and heterogeneity was not measured: 'Ask – women's report Yes'; 'Advise – Yes'; 'Assess motivation to quit – often/always'; all the 'Assist' categories; 'NRT Prescription – always', 'NRT Prescription – often/always'.

Table 1 displays the results of the meta-regression of the 'often/always' categories of 'Ask', 'Advise', 'Arrange', and 'Prescribing NRT' from the meta-analysis. 'Assist' only had 5 studies, so the meta-regression was not performed. For nearly all of the measures, none of the

predictors examined significantly explained the heterogeneity of the proportions for the studies. For 'Arrange referral –often/always', country was found to explain some of the differences in proportion of HPs providing this type of smoking cessation care; with Australian and New Zealand studies having significantly higher proportions of HPs reporting 'Arrange referral – often/always' than USA studies (on average). Year was also found to explain some of the differences in proportion with later years having higher proportions of HP reporting this 'Arrange referral- often or always' (on average).

Table 2 shows the quality rating with the Hawker et al tool,[34] for included studies. Over 70% of the studies had some aspects at least that were rated as good, and 20 out of 53 (37.7%) studies that were rated had at least 5 'good' categories out of the 9 available options. Common flaws were lack of clarity about aims, sampling processes not detailed, ethics processes not described, and no suggestions made for further research.

Table 3 shows the quality ratings of the studies, and level of agreement from using the Hawker tool,[34] for the 15 papers that were rated independently by two raters. Coder agreement varied from Poor for two criteria, Fair for four of the criteria, and Moderate for three criteria.

Discussion

This systematic review of 54 studies from 10 countries on a range of HPs who consult with pregnant women who smoke. Thirty-three studies were suitable for meta-analyses for at least one outcome measure. Studies displayed considerable variation in the way they assessed HP provision of each of the 5As. Commonly surveys employed Likert scales that were re-

categorised as 'often or always', or questions forcing a 'Yes/No' option. We pragmatically transformed outcome measures so they could be combined for meta-analysis, over the 5As and their subcategories, resulting in small numbers of studies in each forest plot, which means that interpretations should be cautious. We acknowledge that there was no ideal way to combine these measures. Conceptually, using a scale to quantify responses is quite different from a 'yes' option: the latter may be an option chosen by respondent whether they perform the practice at an frequency from occasionally to always (ie not at all quantified) – therefore we did not combine 'often/always' with 'Yes/No' study measures.

The primary aim to determine the prevalence of the components of SCC that were being practiced by a range of HPs. The review demonstrated several aspects of SCC that could be improved for pregnant women, including those seen in primary care settings. The highest rates were for Ask and Advise, and Assess. Assist and Arrange were consistently lower. Our secondary aim to examine whether SCC differed between different HP types, for pregnant women in high-risk populations, by country, and by year was achieved by meta-regressions of studies reporting practices 'often/always'. Only 'Arrange referral' had a significant result, indicating that year and country could explain some of the heterogeneity, and perhaps indicating an increased awareness of referral options in later years, or in Australia and New Zealand. The 21 studies not included in the meta-analysis, revealed few comparable quantitative studies on HP knowledge, attitudes and the lesser reported practices of BCTs, and the implementation of all components of the 5As together. On the whole HP knowledge base might be insufficient about NRT. Poor understanding about the safety or efficacy of NRT in pregnancy compared to continued smoking may lead to under-prescribing of NRT as a stop smoking aid, however this is likely to be context sensitive as not all countries recommend the use of NRT and clinical guidelines vary across time and even within the same

country.[17] However, all of the studies in the meta-analysis of NRT were from the USA, and considerable variation for prescribing NRT is seen within that one country. Access to HP training for SCC was reported as being limited, and HPs indicated they required more training.

The strength of this study is that, as far as we are aware, it is the broadest and most rigorous systematic review of HP performance of the 5As in pregnancy, including 7 high-income and three low to middle income countries and the only review, to our knowledge, to perform a meta-analysis and meta-regression. We took care to combine outcome measures with like measures, for each of the 5As, wherever possible. Multiple meta-analyses were performed, for each combined measure. The high heterogeneity suggests a cautious interpretation of the results. The review was limited by not being able to determine the cause for the high heterogeneity in the meta-analyses by our meta-regression, except for 'Arrange referral-often/always' which was related to year, and country. We recognise that differing clinical guidelines may have impacted the provision of NRT in pregnancy in some countries. In particular NRT is not recommended for pregnancy in the USA. Additionally, while most countries do use the 5As, there are variations, such as ABC (Ask, Brief Advice, Cessation) in NZ, and Ask, Advise, Action (AAA) in the UK. These have in common the first 2As, and then a variation to shorten the mnemonic or practice. This variation may be a limitation to this study. The quality rating revealed aspects of some papers were poor; findings from these studies may be less reliable. However unresolved discrepancies between the raters indicate a circumspect interpretation.

Two other reviews examined the provision by HP of SCC for pregnant women. Okoli et al's non-systematic review included 28 studies from 6 high-income countries (USA, Australia,

UK, Germany, Canada, and the Netherlands).[27] The review reported that few HPs working with pregnant women use all the components of the 5As. Although more than 50% of HPs in the review asked women about their smoking status and advised pregnant smokers to quit, fewer than 50% assessed motivation, assisted smoking cessation, or arranged follow-up or referrals. Our review highlighted the diversity of the ways different studies surveyed HPs about their use of the 5As, but it is unclear from the Okoli review how these estimates were made. Instead a range was reported for each of the 5As, (for example 'Ask' 73-100%; 'Assess' readiness or willingness to make a quit attempt 42-81%) without the reader being able to determine which studies used Likert scales, if measures were re-categorised, or a dichotomous Yes/No employed. Baxter et al's systematic review included 23 papers from 6 high-income countries, one middle-income country (UK, France, Sweden, USA, Australia, NZ, South Africa) and one multi-nation study, in a qualitative synthesis.[28] Similarly, although Baxter's review reports percentages of HP or women giving or receiving different aspects of the 5As, they do not describe how these questions were asked.[28]

The low rates of reported implementation of components of the 5As may be related to barriers at several levels. Okoli et al's review suggests several important provider-specific, patient-specific, and system or organizational barriers hindering the provision of SCC by HP.[27] Provider-specific barriers centred around HP self-efficacy or perceived ability to provide SCC to pregnant smokers, namely low knowledge, low confidence for counselling and use of NRT, the perception that as HPs they could not influence the patient's smoking behaviour, or that SCC was not their role. In the studies in our review, HP practices also related to HP knowledge and attitudes (optimism and confidence). Patient-level barriers included HP perceptions that pregnant smokers were not interested in quitting, had stressful lives, and HPs not wanting to jeopardise their relationship with the pregnant patient by raising smoking as an issue. System-level barriers included lack of time, resources, training

and protocols, similarly described in our review. Baxter et al's review also reports barriers to providing SCC: discussing smoking cessation depended on whether HPs were able to broach the subject, staff confidence and perception of effectiveness, manner of communication, whether follow-up occurred, time and resource constraints, and service protocols.[28]

One of the included Australian studies explained some of the factors that may impinge on the quality of SCC for pregnant women. Bar-Zeev et al analysed the factors associated with performance of the 5As, and provision of NRT in Australian medical practitioners.[91] In a national study of 378 GPs and OBS, 'internal influences' (including HP confidence for counselling and prescribing NRT, optimism, sufficient time and resources) were associated with a higher likelihood of performing the 5As, whereas 'external influences' (i.e., workplace routines, doctor-patient relationship, comfort raising the issue, perceived priority) were associated with performing the shorter version of Ask, Advise, Refer (AAR).[91,93,94] Furthermore, being an OBS compared to being a GP, low confidence, and uncertainty about safety of NRT, were associated with lower odds of prescribing NRT.[92]

Our objective to determine which aspects of SCC for pregnant women could need improvement, revealed on the whole that 'Assist' and Arrange' were less performed. Assisting pregnant smokers to quit is a vital priority. Unless there are high-quality specialised services to refer pregnant smokers to, it is insufficient for HPs to raise the issue, advise, and assess, without going further to actually assist a quit attempt, and as a duty of care arrange follow up or referral. Psychosocial support coupled with NRT (if needed, available and approved) may give pregnant women the best chance of quitting.[17,95] Various implementation strategies could be considered to improve SCC delivery to pregnant women, which may include HP education and training, promotion of clinical practice guidelines, audit and

feedback, reminders, opinion leaders, incentives, or supervision.[96] Training was reported as an educational need by the HPs in the studies, and worthy of consideration. Training should most urgently focus on the elements of the 5As that are seldom performed, taking into account country-specific needs and guidelines. Training should provide actual skills to HPs in how to assist smokers to quit, and give opportunities to practice and receive feedback on their performance. Evidence-based updates on the use of NRT in pregnancy may be warranted especially if professional college guidelines are not up-to-date, with a caution about jurisdictions that may deter prescribing or access.[17]

Providing access to resources, such as educational and training materials for HPs, evidence-based and culturally-appropriate patient information sources, and affordable NRT, will demand changes to policy in some settings and countries. Time is a perennial problem for HPs, however changes in practice protocols, and a whole-of-service approach, could support pregnant women to receive the time investment warranted by such an important issue for their own and their baby's health. Additionaly, policy changes to provide accessible and culturally-appropriate referral options are critical. Further research is warranted to understand which interventions can successfully improve HP performance of the 5As, and whether other models, such as the AAR,[96] the ABC (Ask, Brief Advice, Cessation),[97] or ABCD (Ask, Brief Advice, Cessation, Discuss)[98] approach may better facilitate HP implementation of SCC, and correspondingly improve quit rates in pregnant women. Standardised methods to assess the provision of SCC and the 5As in research or program evaluations, would aid future comparisons.

Conclusions

In a systematic review of HPs' provision of SCC for pregnant women in 10 countries, meta-analyses were performed after combining like measures across studies where feasible. Pooled percentages revealed that HPs reliably 'Ask', 'Advise' and 'Assess' pregnant women about tobacco smoking. 'Assist', including assist by 'prescribing NRT', and 'Arrange referral' were much lower, and may be improved by appropriate interventions such as training, incentives or prompts. Meta-regressions were significant only for 'Arrange referral' for year and country. Further research may be required to understand other factors driving the heterogeneity between different studies. Standardised methods to assess the provision of SCC and the 5As are warranted.

Author Statement: GSG was responsible for the design of the review, publishing the protocol in PROSPERO, oversaw all aspects of the study and wrote the manuscript. LT conducted the searches with YB. LS did the data extraction, and with YB the quality analysis. KP conducted the meta-analyses and meta-regressions. GRG assisted GSG in writing the methods and results sections, and preparing tables. BB advised on study design and critically reviewed the manuscript. YBZ advised on manuscript drafts as senior author. All authors reviewed and approved the final manuscript.

Declaration of interests

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Figure Legends:

Figure 1: Prisma Flow Chart of included studies

Figure 2: Comparison of pooled percentatges of selected categories of 'often/always'

Tables

Table 1: Meta-regression analysis of HP practices performed 'often/always'

Predictors	ASK	ADVISE	ASSIST	ARRANGE	NRT
N studies	9	7	5***	6	6
No predictors					
I^2 resid	96%	91.9%	72.9%	95.9%	97%
τ^2	0.008	0.0304	0.003	0.019	0.017
Provider type					
p-value	0.18	0.487	0.134	0.898	0.304
I^2 resid	95.6%	87.7%		97.4%	94.8%
τ^2	0.006	0.031		0.029	0.013
High risk					
p-value	0.909	**	0.43	0.62	**
I^2 resid	96.4%			96.7%	
τ^2	0.009			0.021	
Country					
p-value	0.845	0.252	0.185	0.037	0.903
I^2 resid	96.5%	89.4%		84.5%	97.6%
τ^2	0.012	0.022		0.006	0.021
Year					
p-value	*	*	*	0.013	*
r^2 resid				73.9%	

** non-linear, model not performed, ** no high risk populations, ***too few studies, I2 and τ^2 not available*

Table 2: Quality assessment of 54 included studies

Author (year)	Abstract and title	Intro and aims	Method and data	Sampling	Data analysis	Ethics and bias	Results	Transferability	Implications and usefulness
Abatemarco (2007)	Good	Good	Fair	Good	Fair	Fair	Poor	Good	Good
Amarin (2005)	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Fair
Bakker (2005)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair
Bar Zeev (2017)	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good
Beenstock (2012)	Good	Good	Good	Good	Good	Fair	Good	Good	Good
Berruetas (2016)	Fair	fair	Fair	Good	Fair	Fair	Good	Good	Good
Bonollo (2002)	Good	Good	Good	Fair	Good	Good	Fair	Fair	Fair
Bull (2006)	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Good
Castrucci (2006)	Fair	Fair	Fair	Fair	Fair	Very poor	Fair	Fair	Fair
Chang (2008)	Good	Good	Good	Fair	Fair	Good	Fair	Fair	Fair
Chang (2013)	Fair	Good	Good	Fair	Good	Good	Fair	Fair	Good
Clasper (1995)	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Coleman-Cowger (2014)	Good	Fair	Good	Good	Fair	Very poor	Fair	Fair	Good
Condliffe (2005)	Good	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair
Cooke (1996)	Good	Fair	Fair	Good	Good	Fair	Good	Good	Good

Cooke (1998)	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair
Eiser (1999)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair
England (2014)	Good	Good	Fair	Good	Good	Good	Good	Good	Good
Floyd (2001)	Fair	Fair	Fair	Poor	Fair	Fair	Fair	Poor	Fair
Glover (2008)	Fair	Fair	Poor	Fair	Poor	Fair	Fair	Fair	Fair
Grange (2006)	Poor	Fair	Poor	Fair	Fair	Poor	Fair	Fair	Fair
Grimley (2001)	Good	Good	Good	Good	Fair	Good	Good	Fair	Good
Hartmann (2007)	Good	Good	Good	Fair	Fair	Good	Good	Fair	Fair
Helwig (1998)	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Herbert (2005)	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Hickner (1990)	Fair	Poor	Fair	Fair	Fair	Poor	Fair	Fair	Fair
Hoekzema (2014)	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair
Howard (2013)	Good	Good	Good	Good	Good	Good	Good	Fair	Good
Jones (2003)	Good	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Jordan (2006)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Good
Lemola (2012)	Good	Good	Good	Good	Good	Fair	Good	Good	Good
Mabbutt (2002)	Good	Good	Fair	Poor	Fair	Fair	Good	Poor	Fair
McEwen (2003)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mejia (2010)	Good	Fair	Fair	Good	Fair	Poor	Fair	Fair	Good
Moran (2003)	Fair	Good	Good	Good	Good	Poor	Good	Good	Good
Mullen (1998)	Fair	Good	Fair	Fair	Good	Poor	Fair	Fair	Fair
Murphy (2016)	Fair	Fair	Fair	Good	Fair	Good	Fair	Good	Good
Oncken (2000)	Good	Fair	Good	Good	Good	Poor	Good	Good	Fair
Owen (1999)	Poor	Fair	Poor	Very poor	Poor	Poor	Poor	Fair	Fair
Passey (2012)	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Good
Passey (2015)	Fair	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair
Passey (2014)	Fair	Fair	Fair	Fair	Good	Fair	Good	Fair	Good
Price (2006)	Good	Fair	Good	Fair	Good	Poor	Good	Fair	Good
Price (2006)	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Pullon (2004)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair
Roske (2009)	Good	Good	Fair	Good	Good	Fair	Good	Good	Fair
Solberg (2010)	Good	Good	Good	Good	Good	Good	Good	Good	Good
Tappin (2010)	Fair	Fair	Fair	Good	Poor	Fair	Fair	Fair	Fair
Thyrian (2006)	Good	Good	Good	Good	Good	Good	Good	Good	Good
Tong (2008)	Good	Good	Fair	Good	Fair	Poor	Fair	Good	Fair
Tran (2010)	Good	Fair	Good	Good	Good	Fair	Good	Good	Good
Tzelepis (2017)	Good	Fair	Good	Good	Good	Good	Good	Good	Good

Walsh (1995)	Good	Fair	Good	Fair	Fair	Fair	Good	Fair	Fair
Zapka (2000)	Good	Fair	Good	Fair	Good	Fair	Good	Fair	Fair

NA – not applicable as was a letter to the Editor

Table 3: Findings from agreement of quality rating analysis of coders using the Hawker tool

	Mean Rating (SD) 1 (very poor) to 4 (good)		*Agreement*	
Study Criteria	***Rater 1***	***Rater 2***	***Weighted kappa (95%CI)***	***Agreement***
Abstract and title	2.4 (0.6)	2.3 (0.6)	0.13 (-0.41, 0.68)	Poor
Intro and aims	2.3 (0.5)	2.1 (0.3)	0.25 (-0.17, 0.67)*	Fair
Method and data	2.2 (0.6)	2.3 (0.6)	-0.15 (-0.74, 0.43)	Poor
Sampling	2.1 (0.8)	2.3 (0.6)	0.43 (0.10, 0.76)	Moderate
Data analysis	2.1 (0.6)	2.1 (0.5)	0.51 (0.03, 0.99)	Moderate
Ethics and bias	1.9 (0.8)	1.9 (1.0)	0.38 (0.13, 0.63)	Fair
Results	2.3 (0.7)	2.4 (0.5)	0.26 (-0.11, 0.62)	Fair
Transferability	2.2 (0.4)	2.3 (0.6)	0.21 (-0.19, 0.61)	Fair
Implications and usefulness	2.4 (0.6)	2.5 (0.6)	0.58 (0.18, 0.98)	Moderate

*only 2 levels, therefore Kappa rather than weighted Kappa used

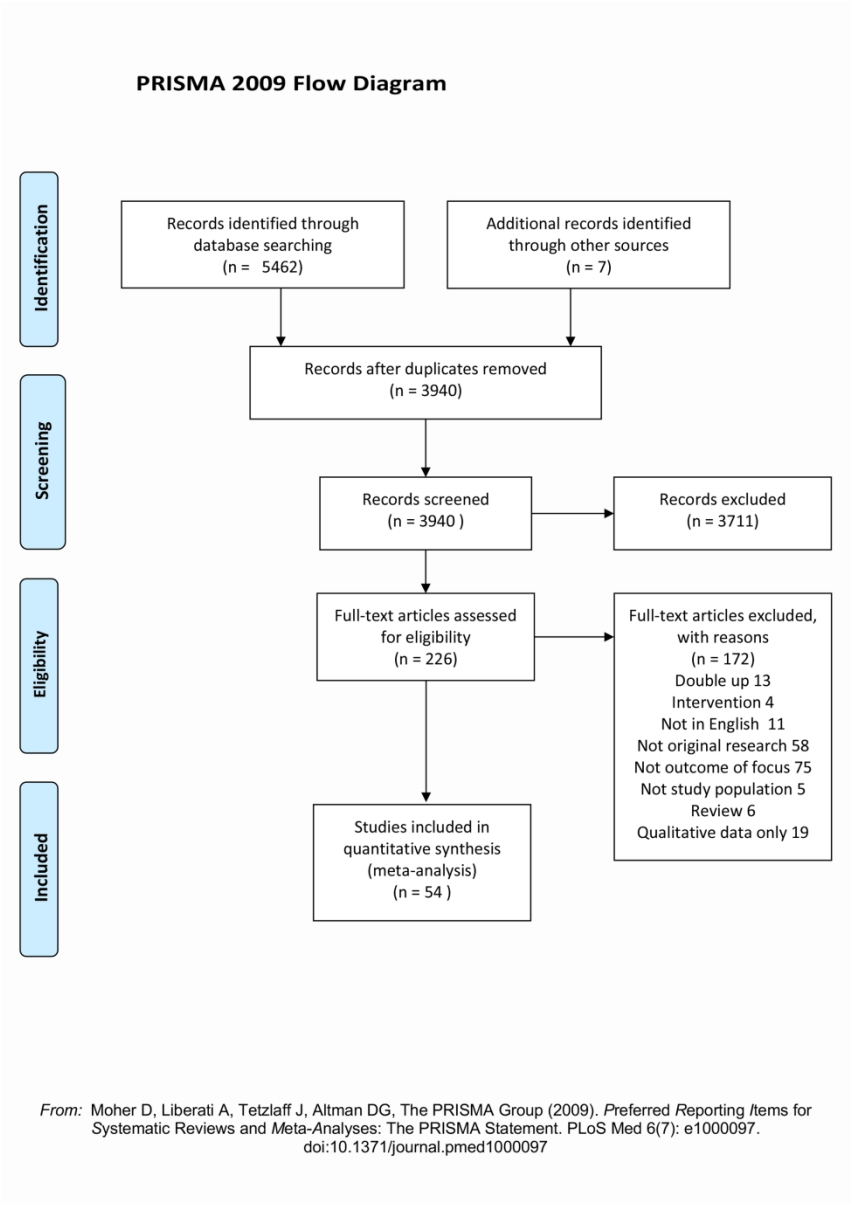


Figure 1: Prisma Flow Chart of included studies

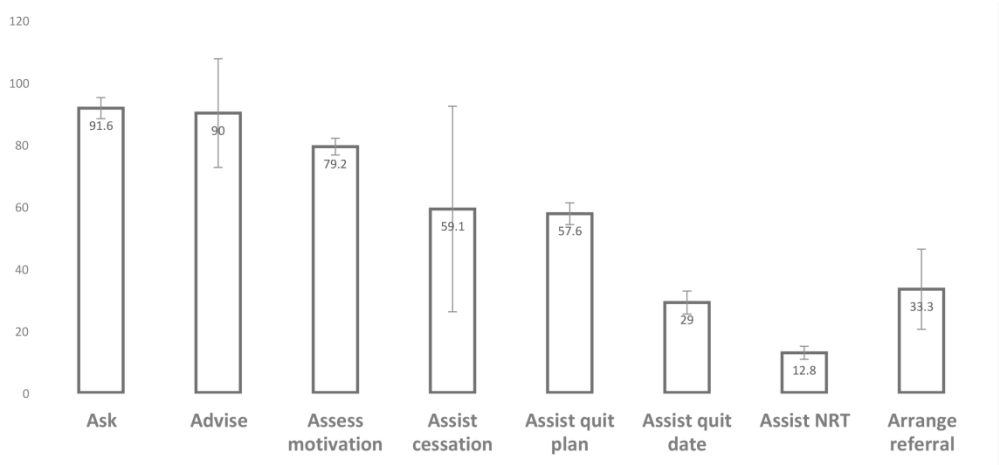


Figure 2: Comparison of pooled percentatges of selected categories of 'often/always'

Supplementary Table 1: Key search terms for systematic review on Health Providers' Practices for Smoking Cessation Care in Pregnancy

Health Professional	Attitudes and Practices	Smoking	Pregnancy
Allied health personnel	Health Knowledge, Attitudes, Practice	Tobacco dependence treatment	Maternal behaviour
General practitioner	Attitude of Health Personnel	Maternal tobacco smoking	Perinatal Care
Medical practitioner	Knowledge	Smoking Cessation	Pregnancy
Health Professional	Perception	Tobacco use disorder	Maternal
Health personnel	Practice	Nicotine dependence	Mother
Family Practice	Belief	Smoking treatment	Preg*
Specialist	Capacity	Smoking	Antenatal
Physician	Capability	Smok*	
Doctor	Confidence	Tobacco	
Midwife	Priority		
Gynaecology	Barrier		
Obstetrics	Attitude		
Clinician	Skill		
Dentist	Ability		
Pharmacist			
Consultant			

Note: all search terms were "exploded", meaning the terms underneath these keywords were also searched for.

Supplementary Table 2: Characteristics of included quantitative (N=54) studies

First Author (year) Country	Study Focus	Population & Risk Category (high/low)	Study Aim(s)	Ask	Advise	Assess	Assist	Arrange follow up	NRT	Summary of results
Abatemarco (2007) USA	Health Providers (Midwives)	Low risk	Determine how New Jersey's certified nurse-midwives (CNMs) provide tobacco screening and cessation counselling to pregnant smoking women.	X	X	X	X	X		Nearly all midwives routinely ask, advise, and assess; while fewer address quit dates, or discuss medication options (assist) and perform follow-up activities (arrange). Midwives identify a need for training.
Amarin (2005) Jordon	Health Providers (Obstetrician & Gynaecologists)	Low risk	Establish tobacco use amongst obstetricians/gynaecologists and assess awareness of the impact of smoking on health; routine practices with patients who smoke; opinions of factors contributing to tobacco use and their perceived barriers to counselling improvements.	X	X		X			A high proportion of obstetricians/gynaecologists are smokers. Most health professionals associated smoking with low birth weight and sudden infant death syndrome. Fewer associated smoking with infertility, ectopic pregnancy, placenta praevia, abruption placentae and cancer of the uterine cervix. Friends, stress, parents' attitude, genetic predisposition, income and education were implicated factors for smoking. Current smokers were more likely to permit smoking in their practices. Non-smokers were most inclined to record their patients' tobacco habits. Only 54.3% provided cessation counselling. Lack of time and inadequate training were perceived barriers.
Bakker (2005) Netherlands	Pregnant Women	Low risk	To identify relevant factors that hamper or promote the provision of effective smoking cessation advice and counselling.			NA*				In general, midwives were motivated to provide their clients with smoking cessation advice, however, were less comfortable guiding women through the cessation process.
Bar-Zeev (2017) Australia	Health Providers (GPs & Obstetricians)	Low risk	Examine: 1) Self-reported provision of SCC to pregnant women by GPs and Obstetricians in Australia; 2) Barriers and enablers to SCC and 3) Associations between	X	X	X	X	X	X	Almost all clinicians (98%) reported that addressing smoking during pregnancy is a high priority, and that they feel comfortable raising the issue with a pregnant woman (95%). TDF statements receiving the lowest agreement(agree & strongly agree) were having sufficient time (41%), sufficient resources (47.5%) and optimism of intervention effectiveness (35%). Dimension reduction revealed two factors: 1) 'Internal influences' including confidence in counselling, confidence in prescribing NRT, optimism, sufficient time and resources; 2) 'External influences' including high priority, benefit relationship,

			health professionals (GP/Obstetrician), knowledge, attitudes, and performance of SCC."						workplace routine, and comfortable raising the issue. Compared to NFASTIH GPs, being an Obstetrician was associated with lower performance of all the 5A's, but with a higher performance of AAR. No difference was found between the performance of the RANZCOG GPs and Obstetricians. 'Internal influences' were associated with a higher performance of all the 5A's, whereas 'External influences' were associated with a higher performance of AAR. Performing all the required 5A's was done by less than 20% of participants and was associated with barriers that are internal such as low confidence and low optimism. Internal barriers includes confidence in counselling, confidence in prescribing NRT, optimism in intervention effectiveness, sufficient time and resources. External barriers includes high priority, benefit relationship, workplace routine, comfortable raising the issue.
Beenstock (2012) UK	Health Providers (Midwives)	Low risk	Investigate the perceived implementation difficulties of midwives in providing smoking-cessation advice to pregnant smoking women. Investigate relationships between the self-reported behaviour of referring women to smoking-cessation services and demographic and professional variables.			NA*			Midwives were less certain about the consequences of, and the environmental context and resources available for, engaging in this work relative to other TDF domains. The 'propensity to act' was predictive of the self-reported behaviour 'Refer all women who smoke.....to NHS Stop Smoking Services' and mediated the relationship between demographic variables (e.g., midwives' workplace and behaviours). This study supports previous research that the TDF is an appropriate tool to understand the behaviour of healthcare professionals.
Berruetas (2016) Argentina & Uruguay	Pregnant Women	High Risk-Economic-ally deprived	Assess smoking patterns and receipt of 5A's among pregnant women in Buenos Aires, Argentina and Montevideo, Uruguay.	X	X	X	X	X	Among pregnant smokers in Argentina, 23.8% reported that a provider asked them about smoking at more than one prenatal care visit; 18.5% were advised to quit; 5.3% were assessed for readiness to quit, 4.7% were provided assistance, and 0.7% reported follow-up was arranged. In Uruguay, those percentages were 36.3%, 27.9%, 5.4%, 5.6%, and 0.2%, respectively.
Bonollo (2002) USA	Health Providers (Physicians, Nurses, Practitioner, & Nutritionists)	Low risk	To examine in detail the specific content and levels of knowledge among providers caring for low-income pregnant and postpartum women to present a current perspective on counselling related to tobacco addition. Explore provider characteristics related to knowledge levels.			NA*			Providers reported low awareness of the health risks of smoking to the developing foetus/child of pregnant and postpartum women and of the effectiveness of nicotine replacement therapy (NRT) for doubling quit rates. Obstetric (OB) and WIC providers were more aware than PED providers that provider-delivered interventions are effective. Confidence in using counselling steps was significantly associated with general and NRT-related knowledge. NRT-related knowledge, but not general knowledge, was associated with higher performance of intervention steps. Educational programs targeting OB, WIC, and PED providers' knowledge about effective smoking cessation counselling strategies and their confidence in being effective with patients are needed.
Bull (2006) UK	Health Providers (Health Visitors, Midwives, And Nurses)	Low risk	To examine the attitudes, knowledge and practice of health visitors, midwives and practice nurses in relation to smoking cessation interventions with	X	X	X	X	X	All health practitioners claimed to ask if their patients smoked. Most claimed to record smoking status on health records and give cessation advice. Fewer provided advice to partners of women in their care and only a minority had read the NICE clinical guidelines on NRT.

			pregnant women and new parents.							
Castrucci (2006) USA	Pregnant Women	Low risk	Describe the range of risk reduction behaviours among women who continue to smoke after learning of their pregnancy, including reduce tobacco use, eventual cessation and sustained abstinence as well the patient-reported smoking cessation - promoting behaviours of prenatal care providers.				X	X		Smoking cessation was achieved by only a quarter of antenatal smokers, almost 90 percent reduced their cigarette consumption. Antenatal smokers reported that prenatal care providers asked about their smoking (90.6%) and advised about quitting (76.5%). However, only 27.9% were given referrals to smoking cessation programs.
Chang (2008) USA	Pregnant Women & Health Providers (Obstetrics-Gynaecology Resident, Nurse Midwife, & Nurse Practitioner)	Low risk	Examine patient-provider communication about substance use behaviours during obstetric visits.	X	X	X	X	X		Provider responses to smoking disclosures included discussions of risks, encouragement to quit-cut down, affirmation of attempts to quit-cut down, and referral to smoking cessation programs. Providers should discuss behavioural change strategies and motivations with pregnant patients who use substances.
Chang (2013) USA	Health Providers (Nurse Midwife, Nurse Practitioner, Residents, Physician Assistant)	Low risk	Describe obstetric providers' adherence to the evidence-based clinical practice guideline for smoking cessation counselling, the 5 A's (Ask, Advice, Assess, Assist, and Arrange).	X	X	X	X	X	X	Obstetric providers frequently asked about smoking (98%) however, used 3 or more of the 5 A's in only 21% (24) of visits. In no visits did providers use all 5 A's.
Clasper (1995) UK	Health Providers (Hospital Midwives, Community Midwives, General Practitioners, Obstetricians)	Low risk	To inform the development of future smoking cessation interventions in pregnancy by measuring current practice and the associated attitudes and beliefs of the main professionals responsible for the delivery of antenatal care.	X	X		X	X		Most professionals asked about the smoking status of pregnant women, record smoking status and explain the risks of smoking while pregnant. Fewer professionals gave pregnant smokers advice on how to stop or monitored at and reviewed smoking status throughout pregnancy. Most experienced difficulty and a lack of enjoyment while giving smoking cessation counselling. Over half (53%) perceived themselves to be insufficiently trained, whilst few (28%) thought that they possessed the necessary skills.
Coleman-Cowger (2014) USA	Health Providers (Obstetrician & Gynaecologists)	Low risk	To assess current ob-gyn practice patterns related to the management of and barriers to smoking	X	X	X	X	X	X	Ob-gyns estimated that approximated that 32% of pregnant smokers quit during pregnancy, but 50% return to smoking postpartum. The primary barrier was time limitations. Compared with findings from a similar study conducted in 1998, physicians are less likely to adhere to the 5 As smoking cessation guideline at present.

			cessation during pregnancy and postpartum.						
Condliffe (2005) USA	Health Providers (Midwives Grandes E-H, Health Care Assistants)	Low risk	Explore the self-reported smoking-cessation interventions of maternity staff with pregnant smokers and their attitudes towards smoking in pregnancy.		X	X		X	Over two-thirds of respondents (71%) reported not advising any pregnant women to give up smoking within the previous 7 days. However, 64% felt women should not make up their own minds about whether to smoke during pregnancy, and 81% agreed/strongly agreed that many pregnant women would like to give up smoking but need help and advice on how to succeed. Helping a pregnant woman to give up smoking was seen as being one of the most important things a midwife can do by 73% of the respondents. Although the reported attitudes were supportive of the midwife's role in smoking cessation, they did not translate into practice. The level of smoking cessation interventions was low.
Cooke (1996) Australia	Health Providers (Midwives)	Low risk	Assess current practice in smoking cessation interventions by midwives and to examine the relationship between the use of smoking interventions, practitioner's characteristics, and organisational factors.	X	X		X	X	Most midwives used minimal interventions (advice and education) for at least some of their clients. The more skilled and more time-intensive forms of intervention (e.g., counselling, negotiating a quit date, and follow-up) were infrequently utilized. Participants estimated that half their smoking clients were not offered advice about smoking. Organizational factors such as: hospital policy for smoking intervention, type of hospital, size of hospital, cohesion of staff and work pressure predicted the use of smoking interventions. Self-reported ability to intervene for smoking and the level of assessment undertaken were practitioner characteristics which predicted the use of smoking interventions. The barriers that inhibit the use of smoking intervention by midwives are discussed and methods for change canvassed.
Cooke (1998) Australia	Health Providers (Midwives, Doctors: Obstetric Specialists, Registrars and Residents)	Low risk	The aims of the study were to describe the smoking intervention practice of antenatal clinic staff, and to ascertain the organizational and practitioner variables which predict clinician use of smoking interventions.	X	X		X	X	Most antenatal clinic staff did not use the most effective forms of brief interventions for smoking. The presence of specific procedures and training in smoking cessation intervention appeared to be the most important predictors of reported smoking intervention in hospital antenatal clinics.
Eiser (1999) UK	Health Providers (Midwives)	Low risk	Assess a) their attitudes to giving anti-smoking advice to pregnant smokers and whether they perceived this as part of their professional role and b) the types of advice they gave to pregnant smokers as part of their routine practices.	X	X	X	X		Midwives attitudes towards giving anti-smoking advice were generally positive, and almost all reported routinely explaining the health dangers of smoking to pregnant smokers. Among midwives who had never smoked, those who held role attitudes that were more favourable towards anti-smoking intervention reported providing relatively more advice based on warnings of health consequences and an emphasis on abstinence. Among the remainder of the sample, more favourable attitudes predicted greater use of behaviourally-oriented advice to facilitate cessation or smoking reduction, but were unrelated to the use of health warnings and emphasis on abstinence.
England (2014) USA	Health Providers (Obstetrician-Gynaecologist Physicians)	Low risk	Examine screening practices and attitudes of obstetricians-gynaecologists toward new and emerging tobacco products.			NA*			A substantial proportion of obstetrician-gynaecologists reported never or inconsistently screening their pregnant patients for the use of non-combustible tobacco products. Responses regarding the harms of these products relative to cigarettes were mixed and most respondents wanted more information.

Floyd (2001) USA	Health Providers (Obstetric-Gynaecologists)	Low risk	Assess the knowledge, beliefs and practice behaviours of obstetricians/ gynaecologists concerning their patients prenatal use of tobacco and other drugs.	X	X		X	X	X	While screening of prenatal patients for tobacco use and other drug use was reported by survey respondents, providing or arranging for interventions for those screening positives was less often reported.
Glover (2008) NZ	Health Providers (GPs, Registered Midwives)	Low risk	To examine New Zealand general practitioners' GP and midwives' smoking cessation knowledge and support offered to pregnant women who smoke.	X	X	X	X	X	X	GPs are in the ideal position to offer stop-smoking advice, because they usually confirm pregnancy. GPs are most likely to advocate stopping smoking completely; midwives are more likely to advocate cutting down with a view to quitting. Both GPs and midwives would benefit from improved knowledge of the full range of nicotine replacement therapy (NRT).
Grange (2006) France	Pregnant Women	Low risk	To describe the management of tobacco withdrawal in pregnant women.	X	X	X	X			Healthcare professionals seems to offer only rudimentary care. Simple strategies to help women give up smoking are required. The partner is an important target, especially if he can be persuaded to give up at the same time.
Grimley (2001) USA	Health Providers (Obstetrician & Gynaecologists)	Low risk	To determine the adherence to the clinical guidelines for smoking cessation among Ob-gyn physicians within Alabama.	X	X	X	X	X	X	Interventions are needed to motivate, support, and guide OB-GYN physicians to assist and follow-up with their pregnant patients who smoke.
Hartmann (2007) USA	Health Providers (Obstetricians, Midwives, Family Medicine Physicians, Nurse Practitioners and Physician Assistants)	Low risk	To measure the use of best practice intervention including each of the 5 A's and to assess the relationship between best practice and current intervention resources, prior training in smoking cessation intervention and barriers to providing intervention.	X	X	X	X	X	X	Best practice is well-established to promote prenatal smoking cessation yet implemented by only one third of prenatal care providers in North Carolina. In this study, best practice was associated with resources, practice organization, and reimbursement. Augmented use of available resources (e.g., toll-free hot-lines) and adequate reimbursement may promote best practice implementation.
Helwig (1998) USA	Health Providers (Obstetricians, Family Physicians, Midwives)	Low risk	Investigate the usual intervention practices of family physicians, obstetricians, and nurse midwives for their patients who smoke.	X			X	X	X	Maternity care providers underutilize effective methods of smoking cessation for their patients who smoke and rely on less effective methods.
Herbert (2005) UK	Health Providers (GPs)	Low risk	Determine a). General practitioners' confidence in their ability to deliver a range of smoking cessation interventions, including NRT in pregnancy, b). the frequency with which general practitioners recall prescribing NRT in		X			X	X	Most general practitioners (62%) believed NRT to be effective in pregnancy and safer than smoking (70%), but fewer (45%) believed NRT to be safe in pregnancy. GPs who believed NRT use in pregnancy was safer than smoking were most likely to recall having prescribed it. Many general practitioners were unsure about the safety of NRT in pregnancy. The key factor influencing general practitioners' prescribing decisions was a belief that NRT use in pregnancy was likely to be safer than smoking.

			pregnancy and c). The factors that influence general practitioners to prescribe NRT in pregnancy.						
Hickner (1990) USA	Health Providers (Family Physicians)	Low risk	Reports practitioner's attitudes and strategies towards antismoking interventions for pregnant smokers.	X	X	X	X	X	Most physicians routinely assessed smoking status at the first prenatal visit, and advised pregnant smokers to quit smoking during pregnancy. The most frequently used method of intervention was personal counselling (97%), referral to smoking cessation clinics (40%), and behaviour modification (20%). Fifty-seven percent of physicians reported using antismoking pamphlets, and 30% used antismoking posters. 97% were convinced that the benefits of smoking cessation during pregnancy merited their efforts.
Hoekzema (2014) Australia	Pregnant Women	Low risk	To characterise pregnant smokers and to understand their smoking behaviours and preferences for smoking cessation. The specific objectives were to study the smoking patterns, smoking cessation and treatment preferences of pregnant women and to investigate the scope for a smoking cessation program in the antenatal settings.		X	X		X	There were 87 (69.6%) daily smokers and 38 (30.4%) occasional smokers. Smokers mainly had medium (54; 43.2%) or heavy nicotine dependence (45; 36%). Current smokers were younger, Australian born, not living with a partner, from a lower socio-economic background, multigravida and had a smoker in their household or among friends. Although pregnant smokers were aware of the possible complications of smoking, their motivation and confidence to quit (median) on a 10-point scale were 7 and 4, respectively. Most smokers preferred to stop smoking gradually (74; 71.2%). The preferred methods for quitting were medications (49; 47.6%) and hypnotherapy (35; 34.0%). Patches (28; 29.5%) were the preferred dosage form, and nicotine replacement therapy (25; 28.1%) was the preferred medication. Less than half reported that their health professionals discouraged smoking during pregnancy.
Howard (2013) UK	Pregnant Women	High risk – women with mental illness	Investigate whether pregnant women with mental disorders: a). Are less likely to accept referrals to smoking cessation services, b) are less likely to stop smoking by delivery, and c). Differ in their experiences of smoking, smoking cessation and smoking cessation services compared with pregnant women without mental disorders.			X	X		Pregnant women with mental disorders appear more motivated, yet find it more difficult, to stop smoking. Prioritisation of mental health over smoking may thus lead to increasing health inequality for this group.
Jones (2003) UK	Pregnant Women & Health Providers (Midwives)	Low risk	Explore the attitudes of midwives and pregnant women towards smoking cessation advice to understand why it is not a routine part of antenatal care.		X	X			Only 45% of midwives offered smoking cessation advice routinely, although 82% felt it should be a part of the antenatal care (82%). Lack of time (66%) and training (54%) were the major reasons for this. Smoking cessation advice was not a priority for discussion among the midwives compared to topics such as antenatal screening or place of delivery. Women were aware of the dangers of smoking in pregnancy, but those who wanted to quit need more support from their midwives (83%). They ranked smoking cessation as a

										high priority for discussion at the antenatal visit. The midwives did not feel able to offer smoking cessation advice. The main reason being a of lack of time in the antenatal clinic.
Jordan (2006) USA	Health Providers (Obstetricians, Gynaecologist)	Low risk	To assess Ohio obstetrician/gynaecologists' perceptions and use of the 5A's methods of smoking cessation with pregnant patients who smoking.	X	X	X	X	X	X	Obstetrician/gynaecologists face many competing demands for their time and energy, yet 62% believed smoking cessation advice would be of significant value. Physicians with higher levels of efficacy expectations reported significantly greater use of the 5 As. Future research should explore ways to facilitate obstetrician/gynaecologists' use of the 5As method.
Lemola (2012) Switzerland	Health Providers (Gynaecologists, Midwives)	Low risk	Examined whether gynaecologists and midwives engage in screening and counselling of pregnant women and conducting interventions to prevent smoking during pregnancy. Examine control beliefs involving efficacy expectations of practitioner.	X	X		X			Most gynaecologists and midwives reported screening all pregnant patients regarding smoking, explaining the risks and recommending smoking cessation. By contrast, only a minority engages in more extensive prevention efforts. Strong control beliefs were predictive of a higher likelihood of screening and counselling, as well as of engaging in more extensive interventions.
Mabbutt (2002) Australia	Pregnant Women	Low risk	To examine substance use among pregnant women and their partners, to record changes in reported substance use during pregnancy and to determine what advice they received to stop smoking.		X					Routine advice to quit smoking was not the norm for this group who were motivated to attend antenatal classes and possibly more likely to act on quit smoking advice. Of the women and men who did receive advice to quit smoking, the majority of this advice was not from a health professional. Routine advice about quitting smoking should be a mandatory part of antenatal care, especially for disadvantaged groups, where smoking rates are higher. The antenatal setting accesses most pregnant women and provides a population base for comprehensive anti-smoking strategies for them and for their partners. Failure to implement such strategies would be to miss the opportunity for a cost-effective and disseminable public health intervention for pregnant women and their male partners.
McEwen (2003) UK	Health Providers (GPs)	Low risk	Investigate methods of early referral of pregnant smokers.	X				X		From a total of 55 GPs, in 17 practices within a deprived area of South West London, according to predictions from the delivery figures for the previous year, approximately 120 pregnant smokers should be identified within the 9-month period that the study took place. GPs were invited to use whatever form of referral was most convenient to them. Only 8 referrals were received.
Mejia (2010) Argentina and Uruguay	HEALTH PROVIDERS (Obstetricians, Gynaecologists, & Residents)	Low risk	To describe physicians' practices of smoking cessation and second-hand smoke exposure counselling during prenatal visits.	X	X				X	Although 88.9% of practitioners always or almost always advised women to stop smoking, 75% believed it was acceptable for pregnant women to smoke up to 6 cigarettes per day. The risk of SHS exposure was 'always or almost always discussed' by only 34.5% of physicians. Multivariate logistic regression showed that lack of training was associated with less counselling about smoking cessation (OR 0.18; 95% CI 0.04-0.82) and SHS exposure (OR 0.27; 95% CI 0.12-0.59). Current compared to never smokers had lower odds of smoking cessation counselling (OR 0.39; 95% CI 0.05-0.82). Current smokers were less likely than former smokers to counsel about SHS (OR 0.25; 95% CI 0.11-0.62).
Moran (2003) USA	Health Providers (Family Practitioner,	Low risk	To assess how frequently physicians identified the smoking status of pregnant				X			Physicians identified pregnant women's smoking status at 81% of visits but provided smoking counselling at only 23% of visits by pregnant smokers. Physicians were less

	General Practitioner, Obstetrician, & Gynaecologist)		patients and how frequently physicians counselled pregnant smokers.						likely to identify smoking status of non-White pregnant women but no less likely to counsel non-White smokers.
Mullen (1998) USA	Health Providers (Obstetricians)	Low risk	To describe Texas obstetricians' pregnancy smoking cessation counselling activity and to identify attributes associated with consistent, effective counselling.	X			X	X	X	Obstetricians who are not reached by expert reports and guidelines from groups outside their specialty or who do not perceive the seriousness of maternal smoking are less likely to counsel consistently and to use the most effective techniques.
Murphy (2016) South Africa	Health Providers (Midwifes)	Low risk	to assess the knowledge, attitudes, beliefs and current practices of South Africa midwives in relation to providing smoking cessation education or counselling to pregnant women.	X	X					This study identified several constraints to midwives fulfilling this role, which affected their perceived behavioural control. These included stressful working conditions, too little time, a dearth of educational resources and a lack of knowledge of best practice intervention methods and counselling skills. Perceived patient resistance to quitting was a further obstacle.
Oncken (2000) USA	Health Providers (Obstetrics & Paediatric)	Low risk	To assess smoking cessation counselling and nicotine replacement therapy prescription and recommendation practices among obstetric and paediatric providers.		X				X	We found that nicotine replacement therapies are commonly prescribed or recommended to pregnant smokers by obstetric providers, but less commonly to lactating women by paediatric providers.
Owen (1999) UK	Pregnant Women	Low risk	Examines pregnant women's reports of quality and quantity of health professional interventions from 1992 – 1999.		X					Less than 50% of pregnant smokers reported having received advice on smoking from a health professional during their current pregnancy: little change since the question was first asked in 1994. Advice, when given, appeared to have had little impact on smoking cessation, and did not follow best available evidence, namely to quit rather than cut down.
Passey (2012) Australia	Health Providers (AHW, Midwives or Nurses, Doctors)	High Risk-women Aboriginal and Torres Strait Islander	Aims to explore the knowledge and attitudes of health care providers caring for pregnant Australian Aboriginal women regarding smoking risk and cessation and identify factors associate with self-reported assessment of smoking. Optimal and assessment of smoking status.	X					X	Most respondents considered assessment of smoking status to be integral to antenatal care and a professional responsibility. Most (79%) indicated that they assess smoking status in 100% of clients. Knowledge of risks was generally good, but knowledge of cessation was poor. Factors independently associated with assessing smoking status among all women were: employer service type ($p = 0.025$); cessation knowledge score ($p = 0.011$); and disagreeing with the statement that giving advice is not worth it given the low level of success ($p = 0.011$).

Passey (2015) Australia	Pregnant Women	High Risk-women Aboriginal and Torres Strait Islander	Provision of antenatal smoking cessation support: A survey with pregnant Aboriginal and Torres Strait Islander women.	X	X		X			Despite most pregnant women who smoke reporting advice and support to quit, the persisting high prevalence of smoking suggests that this support is insufficient to overcome the many factors pushing women to smoke.
Passey (2014) Australia	Health Providers (AHW, Midwives or Nurses, Doctors)	High Risk-women High risk: Aboriginal and Torres Strait Islander	Supporting pregnant Aboriginal and Torres Strait Islander women to quit smoking: views of antenatal care providers and pregnant indigenous women.			NA*				Current smokers (n = 121) were less positive about the potential effectiveness of most of the 12 strategies than the providers (n = 127). For example, family support was considered helpful by 64 % of smokers and 91 % of providers; between 56 and 62 % of smokers considered advice and support from midwives, doctors or Aboriginal Health Workers likely to be helpful, compared to 85-90 % of providers. Rewards for quitting were considered helpful by 63 % of smokers and 56 % of providers, with smokers rating them more highly and providers rating them lower, than most other strategies. Quitline was least popular for both.
Price (2006) USA	Health Providers (Nurse-Midwives)	Low risk	Perceptions and Use of Smoking Cessation in Nurse-Midwives' Practice.	X	X	X	X	X	X	Few nurse-midwives identified barriers to counselling pregnant patients who smoked, but the most common were lack of time (14%) and not knowing where to send pregnant smokers for treatment (14%). Most respondents believed that nicotine replacement therapy (NRT) would be most likely to reduce the number of pregnant smokers (74%), yet few (26%) were confident in their ability to prescribe/recommend nicotine replacement therapy. Respondents more likely to use 5 A's can be characterized as the following: had higher efficacy expectations in their ability to communicate issues about the 5 A's and had higher outcome expectations regarding the effects of using the 5 A's.
Price (2006) USA	Health Providers (Obstetricians, Gynaecologists)	Low risk	Obstetricians and gynaecologists' perceptions and use of nicotine replacement therapy.	X	X	X	X	X	X	The majority did not prescribe NRT possibly because few respondents received cigarette smoking cessation training in medical school or their residencies. Significant revisions in professional training and more continuing medical education are needed regarding smoking cessation and use of NRT.
Pullon (2004) NZ	Health Providers (GPs Practicing Obstetrics, Midwives)	Low risk	Smoking cessation and nicotine replacement therapy in current primary maternity care.	X	X				X	Only about half of the health professional gave smoking cessation advice to most pregnant women who smoked. They were uncertain about the safety of NRT use in pregnant and breastfeeding women. Most respondents requested more information about NRT use.
Roske (2009) Germany	Health Providers (Midwives, Gynaecologists, Paediatrician)	Low risk	Smoking cessation counselling for pregnant and postpartum women among midwives, gynaecologists and paediatricians in Germany.	X	X		X			Depending on profession, 90 % to 100 % see smoking cessation counselling as their assignment, 17 % to 80 % screen for, 48 % to 90 % document smoking status, and 55 % to 76 % offer brief or extensive counselling. 61 % to 87 % consider training to enhance their knowledge and/or counselling skills necessary. The compliance of providers with the necessity to give support in smoking cessation is very high. However, the status of cessation counselling does not sufficiently correspond to the evidence based requirements.
Solberg (2010) USA	Pregnant Women	Low risk	Disparities in tobacco cessation medication orders and fills among special populations.				X		X	32,733 current users of tobacco, 18,047 of whom had both health insurance and pharmacy claims data available. After adjustment, 15.4% overall had received an order for cessation medications during this year, but only 78% had filled it. Groups receiving fewer orders than their comparison groups were aged 18-34 years or older than 65 years, men, pregnant women, Asians and Hispanics, and those with non-English-language preference, on Medicaid, or with fewer visits. The same groups were less likely to fill that prescription, except patients with non-English preference or Medicaid. There are disparities in both the receipt of cessation medication orders and the likelihood of filling them for some special

									populations. The causes are likely to be complex, but this information provides a starting point for learning to improve this problem.
Tappin (2010) UK	NA	Low risk	To establish a denominator for pregnant smokers in Scotland and describe the proportion who are referred to specialist services, engage in one-to-one counselling, set a quit date and quit 4 weeks later.	X			X		Poor smoking cessation outcomes are a product of current limitations to identification, referral, engagement and treatment. Carbon monoxide breath testing can bypass this difficulty of patient providing faulty information.
Thyrian (2006) Germany	Health Providers (Midwives)	Low risk	To establish a denominator for pregnant smokers in Scotland and describe the proportion who are referred to specialist services, engage in one-to-one counselling, set a quit date and quit 4 weeks later.	X	X		X		Smoking and exposure to environmental tobacco smoke are seen as prominent health threats that midwives reported they addressed routinely, including giving advice to stop smoking.
Tong (2008) USA	Pregnant Women	Low risk	Investigate the attitudes of midwives to counselling women about their smoking behaviour during pregnancy and post-partum.					X	Almost all women reported that their prenatal care provider asked if they smoked, but only 56.7% reported that a provider counselled them to quit smoking. Only 11.5% of women who smoked in late pregnancy used a cessation method, including self-help materials (6.3%); medications (3.9%); face-to-face counselling (1.7%); telephone-based counselling (1.5%); Internet-based counselling (1.3%); and a class or program (1.0%).
Tran (2010) USA	Pregnant Women	Low risk	To explore racial/ethnic disparities in the receipt of optimal smoking cessation counselling during prenatal care.	X	X		X		Of 594 first trimester pregnant smokers, the majority were asked and advised about smoking by a prenatal care provider. However, a substantial proportion of women did not receive assistance to quit and only 42.2% received all three steps. Significant racial/ethnic variations were found only in the Assist step. Compared to non-Hispanic (NH) White women, NH American Indian women had lower odds of receiving all three steps. In contrast, NH Black women had increased odds of receiving all three steps. We conclude that there is a need for prenatal care providers to address tobacco use, especially to Assist quitting, with all pregnant smokers.
Tzelepis (2017) Australia	Health Providers (AHW or Aboriginal Health Education Officers, Child Health Nurses, & Midwives)	High Risk-women Aboriginal	To examine Aboriginal antenatal and postnatal staff confidence, perceived role and delivery of smoking cessation care to Aboriginal women and characteristics associated with provision of such care.	X			X	X	X	Most staff reported they assessed clients' smoking status most or all of the time (92.2%). However, only a minority reported they offered a Quitline referral (42.2%), provided follow-up support (28.6%) or provided nicotine replacement therapy (4.7%) to most or all clients who smoked. Few staff felt confident in motivating clients to quit smoking (19.7%) and advising clients about using nicotine replacement therapy (15.6%). Staff confident with talking to clients about how smoking affected their health had significantly higher odds of offering a Quitline referral and quitting assistance to clients who smoke.
Walsh (1995) Australia	Health Providers (Medical Directors & Nursing Directors)	Low risk	To assess the smoking cessation practices of Australian public antenatal clinics.		X		X	X		Smoking advice was rated an essential activity at the first antenatal visit by 69% of responding directors. Nonetheless, only 12% of clinics indicated they offered relevant training and 4% reported written policies. Results also indicate senior staff may have suboptimal levels of awareness of smoking risks. Clinics used a narrow array of strategies

										to promote cessation. Almost one-third of directors said they advised smokers to cut down rather than stop smoking completely.
Zapka (2000) USA	Health Providers (Physician, Nurse-Practitioner or Midwife, RN, Nutritionists, Nutrition Assistant)	Low risk	Assess providers' performance of smoking cessation counselling steps with low-income pregnant and postpartum women receiving care at community health centres.	X	X	X	X	X	X	Providers in obstetric clinics had the highest scores and those in paediatric clinics had the lowest scores. Nurse practitioners and nutritionists had higher scores than other providers. Clinic type, greater smoking-related knowledge, older age, and perception of smoking cessation as a priority were independently related to better counselling performance. Low scores for performance of steps beyond assessment and advice indicate a need for emphasis on the assistance and follow-up steps of national guidelines. Providers' own commitment to helping mothers stop smoking was important.

NA – Not applicable to study or not described

Supplementary Text 1: Grouping of outcome measures for the meta-analyses

For each outcome (Ask, Advice, Assess motivation to quit, Assess nicotine dependence, Assist, Arrange follow up, Arrange referral, NRT), we looked at the specific measurement that was done to decide whether it was feasible to group together. To achieve this we looked both at data collection method – cross-sectional survey/ audit of patients medical records/ audio-recording of consultation/ women's report through survey or interview; and also on the measure itself that was used – Likert scale/ dichotomous YES/NO question and so forth.

ASK – overall 38 manuscripts had data on ASK. Out of these 12 used a survey measure reflecting asking all of their patients. We included in this analysis the proportion answering always if a Likert scale was used, or the proportion answering Yes if a dichotomous question was used either asking if you ask all of your patients? Or if you ask your patients always? Answers reflecting asking more than 75% of their patients were also considered as Yes for this analysis. 9 other manuscript used a survey measure reflecting asking usually and always – this including the combined answers in Likert scales (always and usually; and/or most of the time and all of the time). Two manuscripts provided data for both these measures (Bar-Zeev et al and Mejia et al). 4 other manuscripts used women's report whether they recall been asked during their pregnancy.

Advice – The same principles as used in ASK (see above). Advice always included 6 manuscripts using either Likert scales or asking whether you always advise your patients to quit. Advice always and often included 9 manuscripts using either a scale of always and often; or always and usually; or advising all and most of women; or a Yes/No question whether you advice routinely (to more than 50% of patients). Since 8 manuscripts used a more general "Do you advise Yes/No" question, without referring to the amount of patients this is done with, these were grouped separately as Advice Yes/No. 4 other manuscripts used women's report whether they recall been advised to quit during their pregnancy.

Assess motivation to quit – 10 manuscripts in total included some aspect of assessing motivation to quit. 1 used audio-recordings. 2 manuscripts used a measure calculating the mean on a different scale (1-5 and 1-3). 1 used women report. 1 reported on % always only. 1 reported on % usually always. 3 manuscripts assessed willingness to quit in general (with no time point included in the question) and reported on the proportion that answered "always and usually " – these were included in the meta-analysis. One paper asked a similar question but defined this as "% always usually assess whether the patient is willing to make a quit attempt within the next 30 days". Since this included a specific time-point it was considered to be different to the other 3 and not included.

Assess nicotine dependence – Only 3 papers included a question on this topic. 1 reported on % always and often; 1 reported on % always; and 1 reported also on % always and often but asked a general question on # of cig. smoked and not specific to assessing nicotine dependence. It was decided not to run a meta-analysis on these as too different.

Assist – This included many different definitions of assist in quitting – some were general about assisting the patient to quit, and some included a more specific method of assisting such as counselling or setting a quit data.

Overall 34 different manuscripts included some kind of question on assisting. 4 manuscripts had data on women's report on whether they recalled been offered any support to quit – these were general such as "Did your doctor or other HCP ever tell you (at least in one visit) about things you could do to quit smoking?", recalled being offered assistance to quit by health providers; report that their provider offered suggestions for quitting, recall health providers offer support to quit smoking yes/no. 3 manuscripts reported on % reporting always and often helping their patients to set a specific quit data – this included a Likert scale of always and often, or arrange setting a quit data with at least 50% of their patients, or arranging this with most and all of their patients. Only 1 extra manuscript reported specifically on a quit date but included a general not specific Yes/No question - % reporting they negotiate a quit date with their patients – therefore this was not included in the meta-analysis. For "Assist-Often-Always-CessationSupport" the same principles as for ASK were applied here as well – 'always and often' was combined with 'always and usually', and with 'most and all of the patients' and with 'to at least 50% of the patients'. Included in this were any questions using this measurement of general counselling or providing support or assistance – total 5 papers. An additional 5 papers were used for the meta-analysis for Assist-Yes-Counselling – this included any general questions about counselling Yes/No, any general statement of proportion reporting counselling. For Roske note that in the paper they separated based on those reporting providing counselling over 10 minutes and those reported providing brief counselling (under 10 minutes) – the total proportion providing counselling Yes/No was calculated combining these two together. Assist always often quit plan – only 2 papers included a measure about a quit plan and/or specific steps needed

to take to quit. Other papers included either other measures for these outcomes (for example a mean), or measured other assist such as assist by providing social support. These were different from each other so were not included in the meta-analysis.

Arrange follow up – Measures were different from each other so no meta-analysis was done. 2 manuscripts included a measure of always/often general follow up with no mention of a time point; 1 reported % following up on all of the patients; 1 measured % always following up but within a week; and 2 reported always/often within a week.

Arrange referral – Similar to the principles used for ASK (see above) – 6 papers measured % always/often referring - always and usually, always and often, all and most of patients. 3 papers measured always – we decided not to do a meta-analysis due to limits of # of meta-analysis, and these were only 3.

NRT – Same principles as for ASK regarding proportion reporting often/always prescribing NRT (4 papers) and proportion reporting always prescribing (4 papers). We also performed a meta-analysis on 6 papers that included a more general measurement of whether they prescribe or not – included in this were proportion reporting prescribing at least sometimes; proportion recalling prescribing NRT in pregnancy; proportion reporting using this method, proportion using this method currently.

Supplementary Forest Plot Figures 1-17

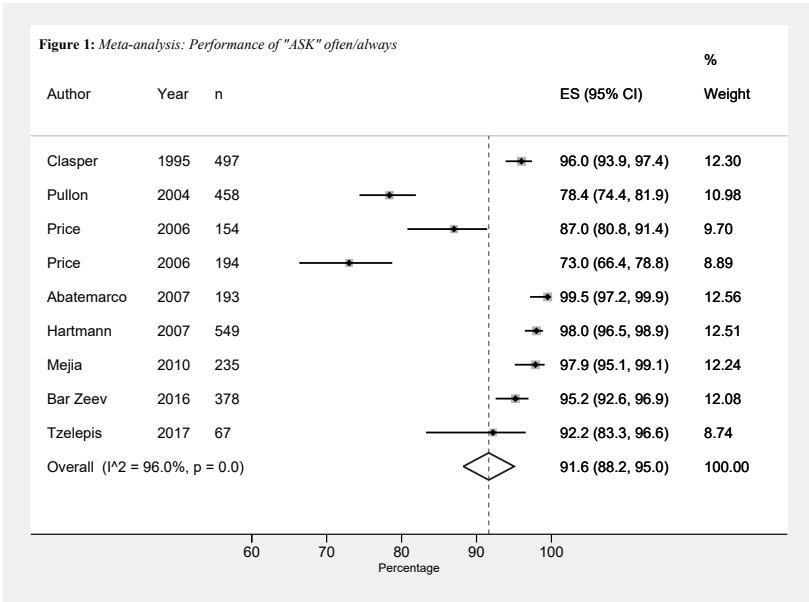


Figure 1: Meta-analysis: Performance of "ASK" often/always
Author
Year
n
ES (95% CI)
%
Weight
Clasper 1995 497 96.0 (93.9, 97.4) 12.30
Pullon 2004 458 78.4 (74.4, 81.9) 10.98
Price 2006 154 87.0 (80.8, 91.4) 9.70
Price 2006 194 73.0 (66.4, 78.8) 8.89
Abatemarco 2007 193 99.5 (97.2, 99.9) 12.56
Hartmann 2007 549 98.0 (96.5, 98.9) 12.51
Mejia 2010 235 97.9 (95.1, 99.1) 12.24
Bar Zeev 2016 378 95.2 (92.6, 96.9) 12.08
Tzelepis 2017 67 92.2 (83.3, 96.6) 8.74
Overall (I^2 = 96.0%, p = 0.0) 91.6 (88.2, 95.0) 100.00
60
70
80
90
100
Percentage

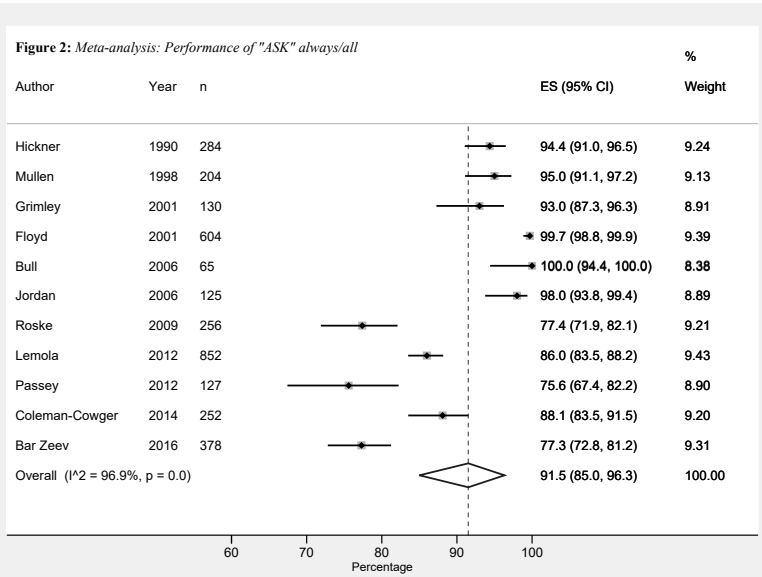


Figure 2: Meta-analysis: Performance of "ASK" always/all
Author
Year
n
ES (95% CI)
%
Weight
Hickner 1990 284 94.4 (91.0, 96.5) 9.24
Mullen 1998 204 95.0 (91.1, 97.2) 9.13
Grimley 2001 130 93.0 (87.3, 96.3) 8.91
Floyd 2001 604 99.7 (98.8, 99.9) 9.39
Bull 2006 65 100.0 (94.4, 100.0) 8.38
Jordan 2006 125 98.0 (93.8, 99.4) 8.89
Roske 2009 256 77.4 (71.9, 82.1) 9.21
Lemola 2012 852 86.0 (83.5, 88.2) 9.43
Passey 2012 127 75.6 (67.4, 82.2) 8.90
Coleman-Cowger 2014 252 88.1 (83.5, 91.5) 9.20
Bar Zeev 2016 378 77.3 (72.8, 81.2) 9.31
Overall (I^2 = 96.9%, p = 0.0) 91.5 (85.0, 96.3) 100.00
60
70
80
90
100
Percentage

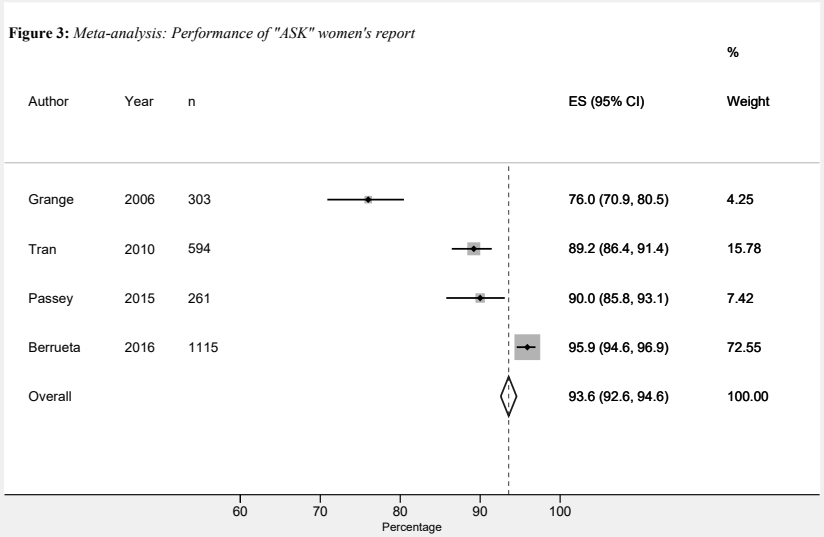


Figure 3: Meta-analysis: Performance of "ASK" women's report
Author
Year
n
ES (95% CI)
%
Weight
Grange 2006 303 76.0 (70.9, 80.5) 4.25
Tran 2010 594 89.2 (86.4, 91.4) 15.78
Passey 2015 261 90.0 (85.8, 93.1) 7.42
Berrueta 2016 1115 95.9 (94.6, 96.9) 72.55
Overall 93.6 (92.6, 94.6) 100.00
60
70
80
90
100
Percentage

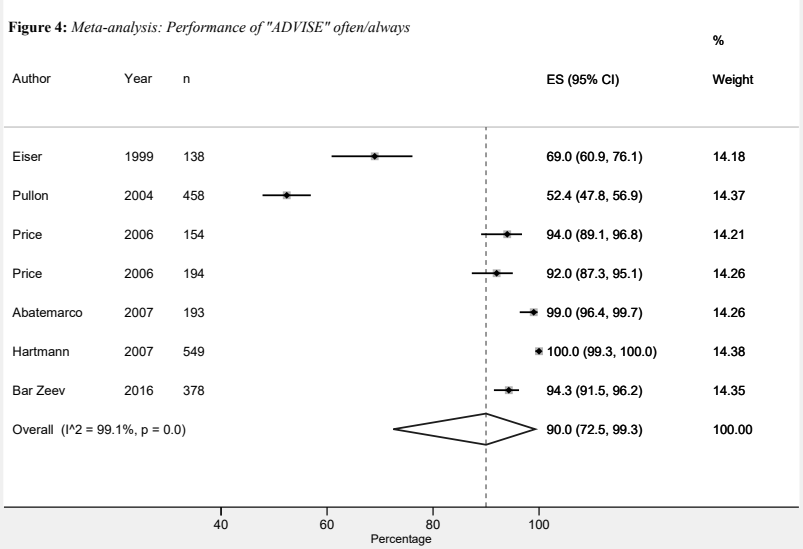


Figure 4: Meta-analysis: Performance of "ADVISE" often/always
Author
Year
n
ES (95% CI)
%
Weight
Eiser 1999 138 69.0 (60.9, 76.1) 14.18
Pullon 2004 458 52.4 (47.8, 56.9) 14.37
Price 2006 154 94.0 (89.1, 96.8) 14.21
Price 2006 194 92.0 (87.3, 95.1) 14.26
Abatemarco 2007 193 99.0 (96.4, 99.7) 14.26
Hartmann 2007 549 100.0 (99.3, 100.0) 14.38
Bar Zeev 2016 378 94.3 (91.5, 96.2) 14.35
Overall (I^2 = 99.1%, p = 0.0) 90.0 (72.5, 99.3) 100.00
40
60
80
100
Percentage

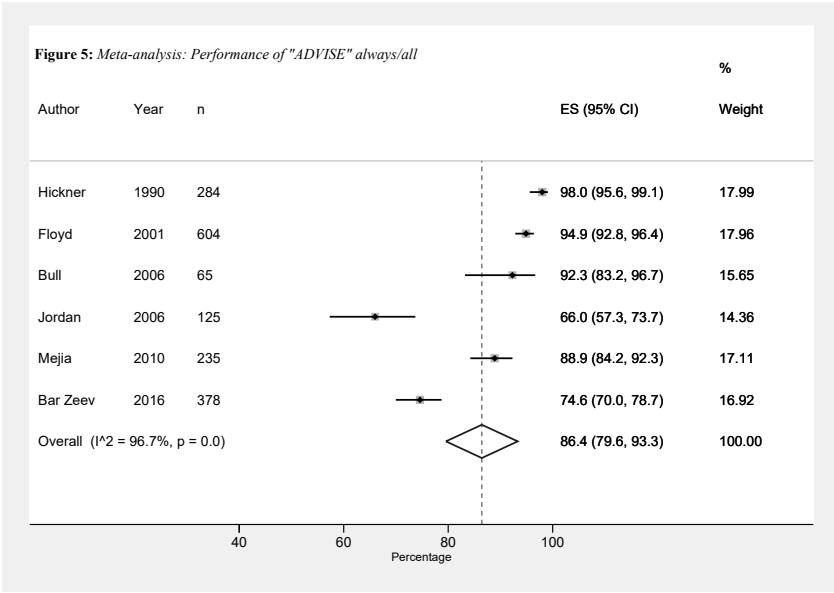


Figure 5: *Meta-analysis: Performance of "ADVISE" always/all*

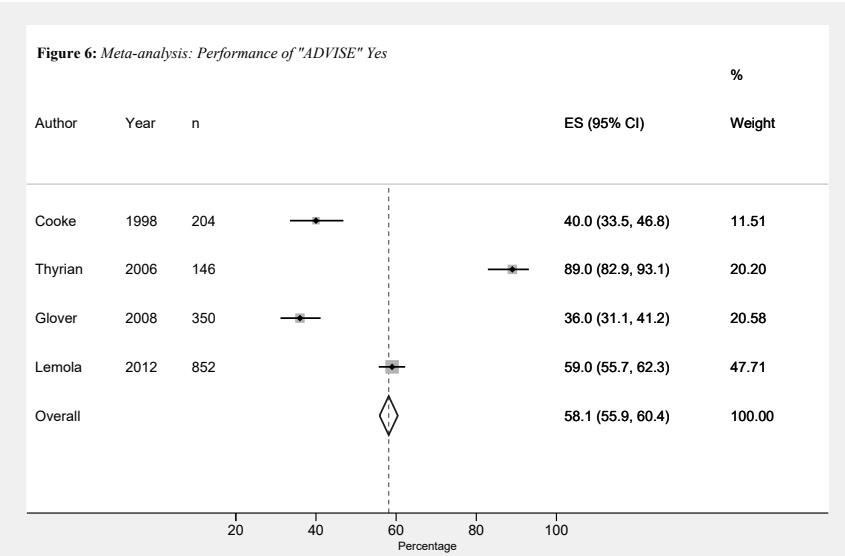


Figure 6: *Meta-analysis: Performance of "ADVISE" Yes*

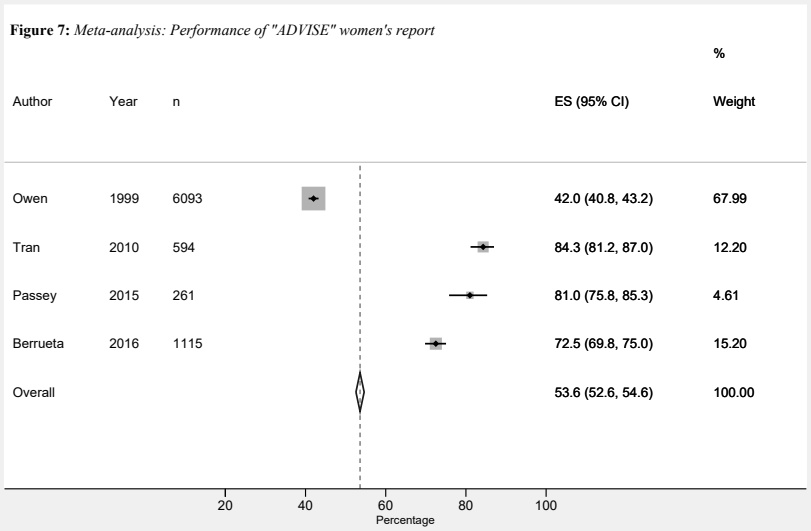


Figure 7: *Meta-analysis: Performance of "ADVISE" women's report*

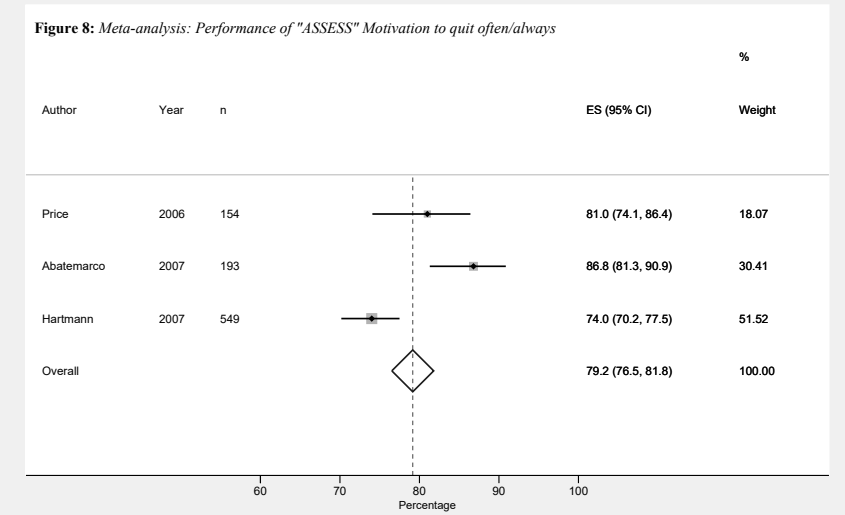


Figure 8: *Meta-analysis: Performance of "ASSESS" Motivation to quit often/always*

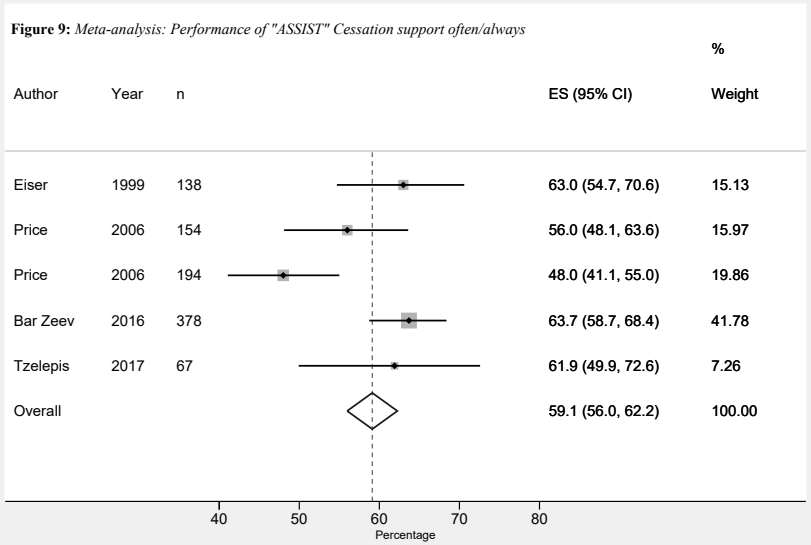


Figure 9: *Meta-analysis: Performance of "ASSIST" Cessation support often/always*

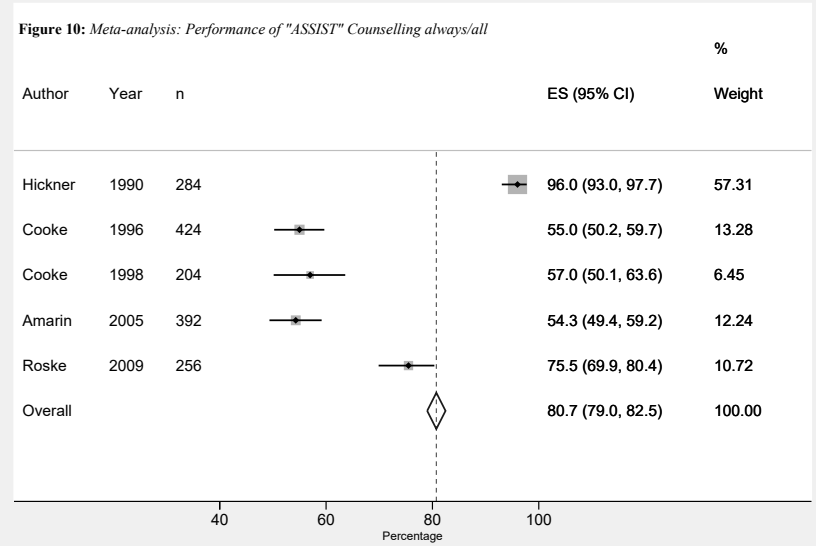


Figure 10: *Meta-analysis: Performance of "ASSIST" Counselling always/all*

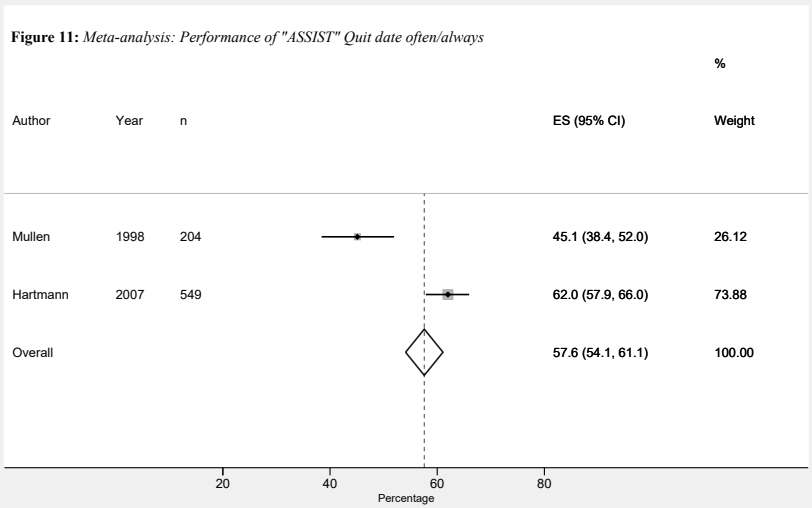


Figure 11: *Meta-analysis: Performance of "ASSIST" Quit date often/always*

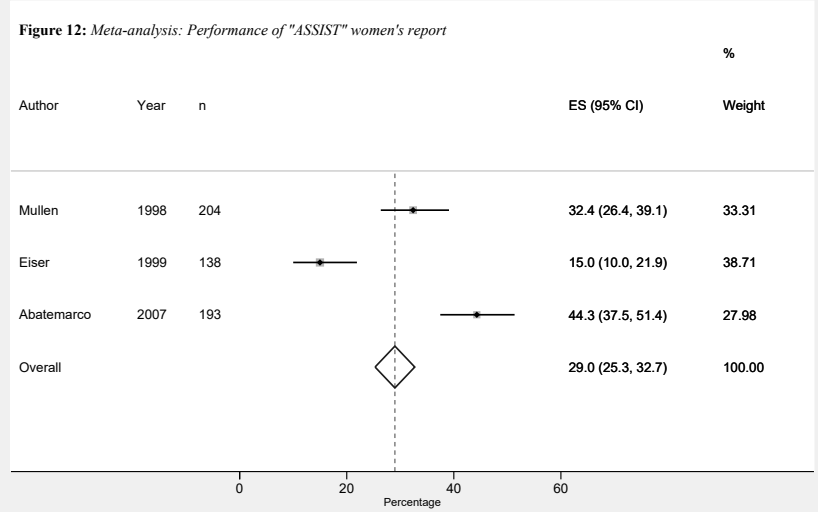


Figure 12: *Meta-analysis: Performance of "ASSIST" women's report*

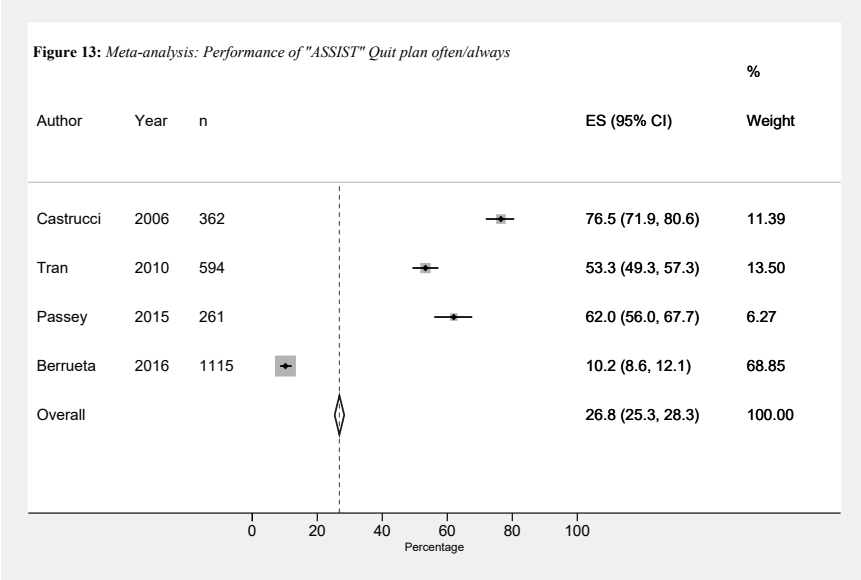


Figure 13: *Meta-analysis: Performance of "ASSIST" Quit plan often/always*

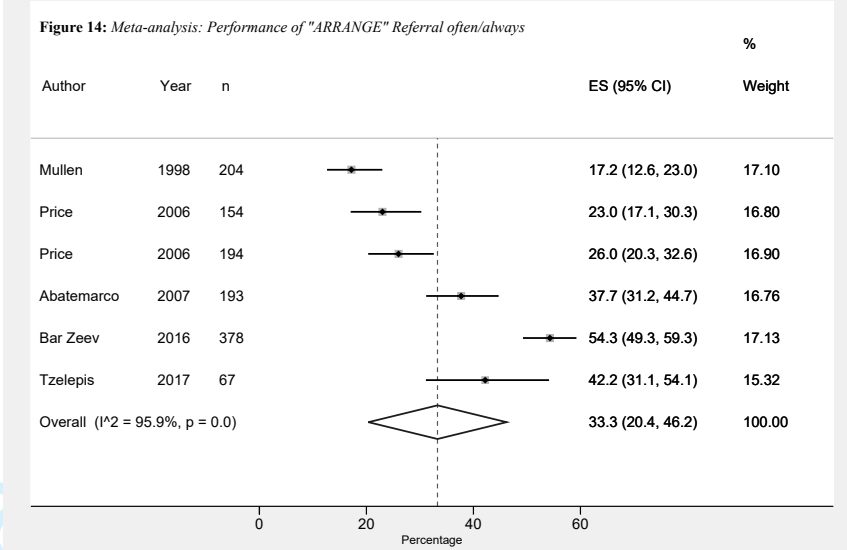


Figure 14: *Meta-analysis: Performance of "ARRANGE" Referral often/always*

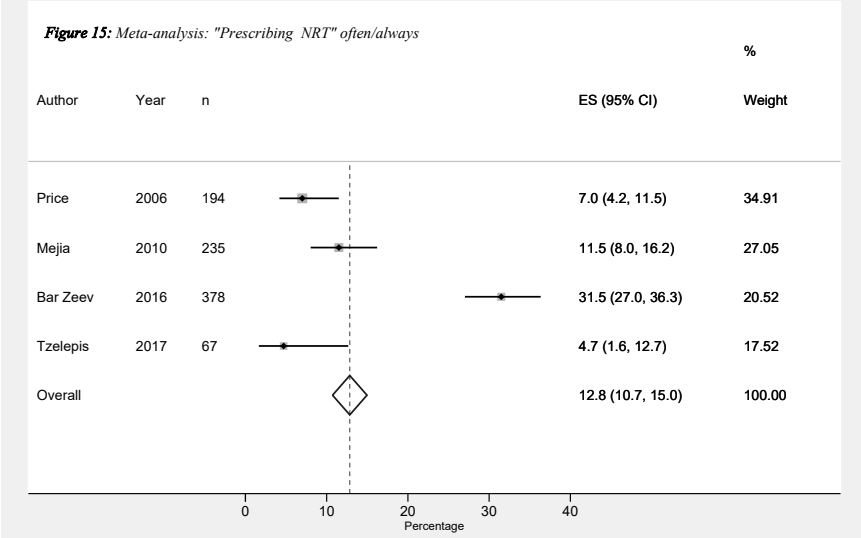


Figure 15: *Meta-analysis: "Prescribing NRT" often/always*

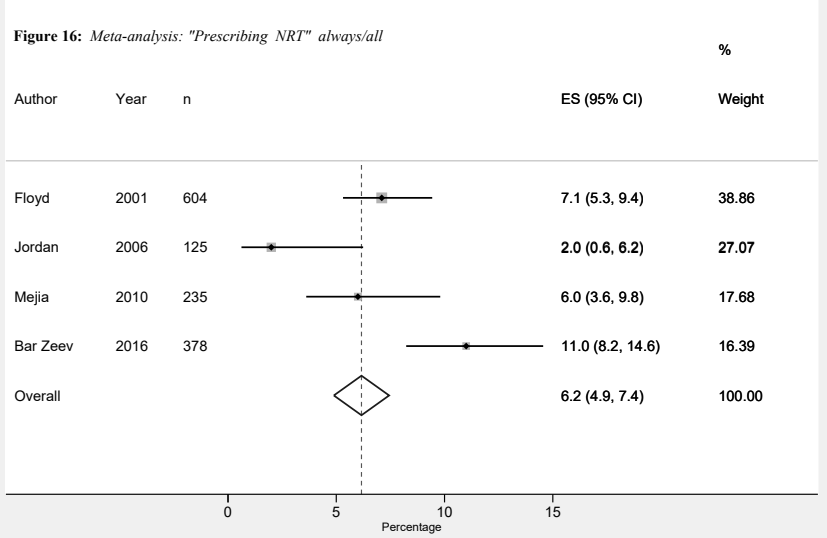
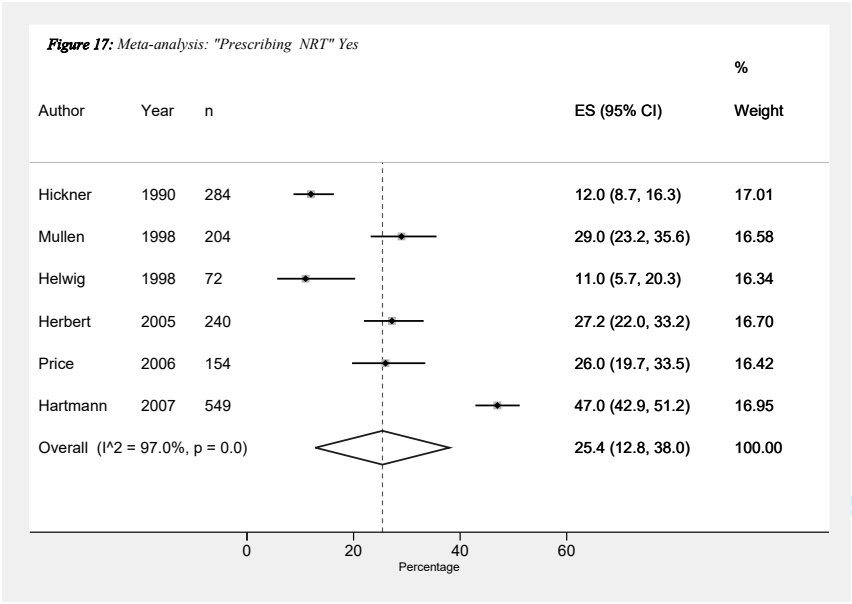


Figure 16: *Meta-analysis: "Prescribing NRT" always/all*



Reporting checklist for meta-analysis of observational studies.

Based on the MOOSE guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the MOOSE reporting guidelines, and cite them as:

Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, Moher D, Becker BJ, Sipe TA, Thacker SB. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. JAMA. 2000; 283(15):2008-2012.

	Reporting Item	Page Number
#1	Identify the study as a meta-analysis of observational research	NA
#2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number (From PRISMA checklist)	2-3
#3a	Problem definition	7
#3b	Hypothesis statement	NA
#3c	Description of study outcomes	11-16
#3d	Type of exposure or intervention used	NA
#3e	Type of study designs used	9, 11

	#3f	Study population	12
Search strategy	#4a	Qualifications of searchers (eg, librarians and investigators)	8
	#4b	Search strategy, including time period included in the synthesis and keywords	7
	#4c	Effort to include all available studies, including contact with authors	NA
	#4d	Databases and registries searched	7
	#4e	Search software used, name and version, including special features used (eg, explosion)	7
	#4f	Use of hand searching (eg, reference lists of obtained articles)	7-8
	#4g	List of citations located and those excluded, including justification	7-8
	#4h	Method of addressing articles published in languages other than English	NA
	#4i	Method of handling abstracts and unpublished studies	8
	#4j	Description of any contact with authors	NA
	#5a	Description of relevance or appropriateness of studies gathered for assessing the hypothesis to be tested	9-10
	#5b	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	8
	#5c	Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	8-9
	#5d	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	NA
	#5e	Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results	9
	#5f	Assessment of heterogeneity	10
	#5g	Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	10

#5h	Provision of appropriate tables and graphics	11
#6a	Graphic summarizing individual study estimates and overall estimate	NA
#6b	Table giving descriptive information for each study included	8
#6c	Results of sensitivity testing (eg, subgroup analysis)	10-11
#6d	Indication of statistical uncertainty of findings	11
#7a	Quantitative assessment of bias (eg. publication bias)	NA
#7b	Justification for exclusion (eg, exclusion of non–English-language citations)	NA
#7c	Assessment of quality of included studies	18
#8a	Consideration of alternative explanations for observed results	21
#8b	Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	21
#8c	Guidelines for future research	21
#8d	Disclosure of funding source	22

BMJ Open

What components of smoking cessation care during pregnancy are implemented by health providers? a systematic review and meta-analysis

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What components of smoking cessation care during pregnancy are implemented by health providers? a systematic review and meta-analysis

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Abstract

Background Pregnancy is an opportunity for health providers to support women to stop smoking.

Objectives Identify the pooled prevalence for health providers in providing components of smoking cessation care to women who smoke during pregnancy.

Design A systematic review synthesising original articles that reported on 1) prevalence of health providers' performing the 5As ('Ask', 'Advise', 'Assess', 'Assist', 'Arrange'), prescribing nicotine replacement therapy (NRT), and 2) factors associated with smoking cessation care.

Data Sources MEDLINE, EMBASE, CINAHL and PsycINFO databases searched using "smoking", "pregnancy" and "health provider practices".

Eligibility criteria for selecting studies Studies included any design except interventions (self-report, audit, observed consultations, women's reports), in English, with no date restriction, up to June 2017.

Participants Health providers of any profession

Data extraction, appraisal and analysis Data were extracted, then appraised with the Hawker tool. Meta-analyses pooled percentages for performing each of the 5As and prescribing NRT, using e.g., 'often/always' and 'always/all'. Meta-regressions were performed of 5As for 'often/always'.

Results Of 3933 papers, 54 were included (n =29,225 participants): 33 for meta-analysis. Health providers included general practitioners, obstetricians, midwives and others from 10

countries. Pooled percentages of studies reporting practices 'often/always' were: 'Ask' (*n*=9) 91.6% (95%CI:88.2,95); 'Advise' (*n*=7) 90% (CI:72.5,99.3), 'Assess' (*n*=3) 79.2% (CI:76.5,81.8), 'Assist (cessation support)' (*n*=5) 59.1% (CI:56, 62.2), 'Arrange (referral)' (*n*=6) 33.3% (CI:20.4,46.2), and 'prescribing NRT' (n=6) 25.4% (CI:12.8,38). Heterogeneity (I^2) was 95.9%-99.1%. Meta-regressions for 'Arrange' were significant for year (p=0.013) and country (p=0.037).

Conclusions Health providers 'Ask', 'Advise' and 'Assess' most pregnant women about smoking. 'Assist', 'Arrange' and 'prescribing NRT' are reported at lower rates: strategies to improve these should be considered.

Registration PROSPERO 2015:CRD42015029989.

Strengths and limitations of this study

- Comprehensive meta-analysis and meta-regression of health providers implementation of the 5As combining like measures for smoking cessation care.
- Fifty four studies from 7 high-income and three low-middle income countries includes disciplines of medicine, nursing, and allied health.
- High heterogeneity in the meta-analyses was unexplained by the meta-regressions, except for 'Arrange referral-often/always' which was related to year, and country
- Quality ratings of some papers were poor - findings from these studies may be less reliable.
- Review aids in determining which components of smoking cessation care are less reliably implemented in pregnancy.

Keywords: smoking, health care providers, smoking cessation, maternal health, pregnancy

Word count: 4724

Introduction

Smoking during pregnancy carries high risks for mother and child, including obstetric complications for the mother,[1] and for the baby, premature birth, growth restriction, low birth weight, still-birth, and congenital defects.[1,2] Longer-term effects on the child include respiratory illnesses, learning and behavioral problems, and increased risks of chronic diseases,[1,2] and of taking up smoking in adolescence.[3]

Smoking during pregnancy remains a prevalent behaviour in many countries, with estimated smoking prevalence rates ranging from 0.2% to 38.4%.[4] Pregnancy is a time when women are more likely to be motivated to stop smoking.[5] However, disadvantaged women, including women from minority and Indigenous populations where there is a high prevalence of community smoking, also smoke at higher rates and are less likely to try to stop smoking, or succeed than more advantaged women among whom smoking prevalence is lower.[6, 7] Also, less likely to stop smoking are women who are: of low socio-economic status,[6] multi-parous,[6] adolescents,[8] partnered by smokers,[6] and those experiencing: alcohol or substance use,[8] depression,[9] life stressors,[10,11] or intimate partner violence.[12] Women frequently reduce tobacco consumption when discovering they are pregnant,[11,13] indicating a consciousness about the risks, but may be less likely to abstain than non-pregnant women.[14] Pregnant women report a lack of support for smoking cessation, and that health providers (HP) consider cutting down to be acceptable.[15,16]

HPs in primary care have a critical role to offer advice and support women to stop smoking during pregnancy.[17] Ideally smoking cessation care (SCC) includes counselling and pharmacotherapy – most successful when combined.[17,18] In pregnancy, the effective use of

pharmacotherapy is less certain, and clinical guidelines vary across and within different countries.[17] In pregnancy, only nicotine replacement therapy (NRT) is recommended, but not consistently advised for use in pregnancy in all countries,[17,19] for example NRT is not advised in the USA for use in pregnancy,[20] but it is more routinely prescribed in the UK.[21] Clinical guidelines in the UK, Australia, New Zealand and Canada recommend that a woman should initially endeavour to quit without medication, but if she cannot, NRT can be prescribed.[17 22-25]

The 5As ('Ask (about smoking)', 'Advise (to quit)', 'Assess (motivation and/or dependence)', 'Assist (with cessation)', and 'Arrange (follow-up or referral)') has been adopted in many countries as a strategy for HPs to deliver all the important components of SCC.[26] Several studies have examined the performance of the 5As in pregnancy. Two reviews summarised the literature . Okoli et al's integrative review reported on HP performance of components of the 5As. While authors reported more than 50% of HPs Ask and Advise about smoking, and less than 50% Assess, Assist or Arrange (referral or follow-up), it is unclear how these estimates were calculated. This is an important limitation considering the variable ways studies collect data and report them,.[27] Baxter et al's qualitative systematic review, on the factors that influenced uptake of interventions by pregnant women, included studies on HP and women's reports of their receipt of SCC, and noted variation between HPs for recording smoking status and advice.[28] As neither review included a meta-analysis, it is timely and important from the point of view of rigour to have a definitive evaluation of HP practices, and furthermore to accurately inform recommendations to guide strategies to improve SCC. An urgent need for research to increase the uptake of smoking cessation interventions, and improve quit rates in pregnant women who smoke has been identified by Siddiqi and Mdege [29]

The objective of this systematic review was to summarise published empirical research of eligible studies from a range of HPs who consult with pregnant women who smoke, and synthesise findings with meta-analyses where feasible. The primary aim was to determine the prevalence of the components of SCC that were being practiced, including the 5As, prescribing NRT, and related behaviour change techniques (BCTs - observable and replicable components designed to change behaviour),[30] thus determine which aspects of SCC need improvement. A second aim was to examine which factors were associated with delivery of the 5As, and NRT prescribing i.e., HP types, country, year, and pregnant women in high-risk populations. We also examined data about knowledge and attitudes of the HPs to inform their practices.

Methods

Data were identified by searches of MEDLINE, EMBASE, CINAHL and PsycINFO, and reference lists from relevant articles. Where possible, search terms were matched to MESH or database specific subject headings, and used as keywords. Search terms included (Supplementary File Table 1): pregnancy (e.g., perinatal care, mother), smoking (e.g., nicotine dependence, smoking cessation), health professional (e.g., general practitioner, midwife), and attitudes or practices (e.g., capacity, belief). Searches were performed in September 2015; additional studies included until June 2017.

Inclusion criteria: peer-reviewed full papers on SCC to pregnant smokers by any HP in any setting, restricted to English language, with no date restrictions. Quantitative studies and/or quantitative data from mixed methods studies with any study design

were included, comprising self-reported provision of SCC by HPs, reported receipt of SCC by pregnant women, or other indicators e.g., chart audit or audio-recordings of consultations. For this review, SCC was based on the 5As: asking about smoking, advising about quitting, assessing motivation to stop smoking or nicotine dependence, assisting to quit, and arranging follow up or referral.[26] In addition, we included papers reporting HP knowledge, attitudes, and other practices e.g., advising about relapse and smoke-free homes, discussing psychosocial contexts of smoking, involving family members or partners, prescribing NRT, and other BCTs (e.g., setting a quit date, making a quit plan, providing resources and self-help materials, aiding social support, encouraging smoke-free environments, and monitoring carbon monoxide readings).[31,32] Exclusion criteria: intervention studies and studies in non-peer-reviewed literature; studies on pre-conceptual and post-natal care. Additionally, 10 papers that did not have a main focus on the review topic and/or reported minimal data about the topic such as one line or one data item in a full paper, were excluded (list available from authors on request). The review was registered with PROSPERO 2015: CRD42015029989. We used the MOOSE checklist when writing our report.[33]

Two researchers (LT – behavioural scientist, YB - physician) independently screened titles, abstracts, and then full papers and applied the inclusion criteria to determine eligibility. Discrepancies were resolved by consensus, with a third researcher (GSG) acting as adjudicator, when agreement was not reached. Studies that met all criteria were retained for full review. One researcher completed data extraction (LS) with a second (YB) extracting 20% of articles, then results compared. A summary table (Supplementary File Table 2) was developed from this data (GRG, GSG). The characteristics of each study were examined including aims, setting, country, sample characteristics, study focus (HP or women), HP type,

study design and method, measures, extracted results for each of the 5As, prescription of NRT, and whether the study addressed the provision of BCTs, and if so a description of the BCTs (e.g., setting a quit date, increasing self-efficacy, monitoring carbon monoxide reading, validating abstinence).

As the studies overall were of all types of design, a quality assessment of the quantitative and mixed studies was carried out using Hawker et al's tool for reviewing disparate data systematically.[34] This was chosen in the absence on any consensus on the best tool, as we were including quantitative and mixed method studies in the review. LS rated all studies using the tool (20% double-rated by YB). Studies were included irrespective of quality.

Quantitative data were presented as percentages and counts were possible, and meta-analyses made for estimates of each of the 5As of SCC provision, and prescribing NRT. A narrative analysis summarises other studies or outcomes, including BCTs where reported. For each outcome measure we looked at the specific measurements across studies to determine whether it was clinically appropriate to group them together i.e., Ask, Advise, Assess (motivation to quit, nicotine dependence), Assist (cessation support, quit date, quit plan, prescribe NRT), Arrange (follow up, referral). To achieve this, we considered both the data collection method (cross-sectional survey; audit of patients' medical records; audio-recording of consultation; women's report through survey or interview) and the measure itself that was used (e.g., Likert scale, or a dichotomous Yes/No response, and so forth). General principles applied were as followed (explained in more detail in Supplementary Text 1):

- **'Often/Always'** included survey measures reflecting asking 'often' and 'always', 'usually and always'; and/or 'most of the time' and 'all of the time'). The combined answers in Likert scales were dichotomised for analysis.
- **'Always/all'** included in this analysis was the proportion of HPs answering 'always' or 'all of the time', if a Likert scale was used, or the proportion answering 'Yes' if a dichotomous question was used: either asking 'do you ask all of your patients?' or 'do you ask your patients always?' Answers reporting on 'Asking' more than 75% of their patients were considered as 'Yes' for these analyses.
- **'Yes'** where a survey asked the HP a dichotomous question for example 'Do you advise? Yes/No' were grouped separately as "Advise - Yes"
- Papers describing women's reports were analysed separately from those describing health provider reports

All statistical analyses were programmed using Stata v13.1 (StataCorp LP, College Station, TX, USA). Meta-analyses were performed to examine the performance of each of the 5As, including prescribing NRT, as above. Stata program *Metaprop* was used to pool dichotomized responses for each of the 5As. If more than 5 studies were pooled, random effects modelling (DerSimonian and Laird's method) was used to account for differences in underlying estimates due to study population and design; heterogeneity (I^2) was measured for each reporting type. If the number of studies was low (≤5), fixed effects modelling was used as the between-studies variance (tau-squared), and therefore the mean of the underlying random distribution cannot be estimated with precision; heterogeneity is not presented.[35] Where required, in order to include studies where the percent reporting the outcome was 100%, the Freeman-Tukey Double Arcsine Transformation method was used to stabilize the

variances prior to pooling. Pooled estimates for study outcomes were split by response, and also by HP type. Significance was set as α=0.05 a priori.

For the 'often/always' responses to Ask, Advise, Assist, Arrange, including prescribing NRT, meta-regression (Stata program *Metareg*) was used to examine whether some of the heterogeneity seen in the proportions reported for each study could be explained by HP type (e.g. midwife, general practitioners (GP), obstreticians (OBS), or mixed groups of HPs), high-risk population versus not (e.g., women in low socio-economic groups, Indigenous women, or with mental health diagnoses), country (USA, Europe, Australia/New Zealand, or Other), or year of publication (1990-2017). P-value, changes in heterogeneity (I^2 residual), changes in between study variance (τ^2), and proportion of between-study variance explained by predictor (adjusted R^2) were reported. For year, the linearity of proportion over time was examined, and if a non-linear trend was seen then the meta-regression was not performed. Meta-regressions for the other meta-analyses were not performed.

An analysis of agreement of quality-rating coders was performed. Weighted kappa (ordinal multi-rater - quadratic weighted Kappa) was used to compare the rating of 9 quality study criteria for 15 studies; each criteria was scored on a 5 point scale (Very poor, Poor, Fair, Good, Very Good). Mean (SD) ratings were calculated for each criteria for each rater. Kappa and weighted kappa estimates were interpreted using cut-off criteria specified by Altman.[36] Strength of agreement was < 0.20 Poor; 0.21 - 0.40 Fair; 0.41 - 0.60 Moderate; 0.61 - 0.80 Good; 0.81 - 1.00 Very Good.

Patient and Public Involvement

As a systematic review we did not directly involve any patients or public in the study. However the review was informed by patient and health provider needs. Participants from previous studies reported to us that they were not receiving comprehensive smoking cessation care during pregnancy from their health providers,[16] nor were health providers in a previous study reporting they delivered comprehensive smoking cessation care.[37] This review was responsive to global knowledge about the receipt and delivery of smoking cessation care in pregnancy being a gap in the literature.

Results

Of the 3933 studies found, 54 papers met the inclusion criteria for quantitative review. See Prisma Flow Chart for included studies (Figure 1).

A total of 54 studies were included in this analysis.[37-90] Study details including author, country, study focus (HP, women, or both), population and risk category (high/low), study aims, inclusion of 5As, and summary of results are presented in Supplementary File Table 2. Of these studies, approximately 90% were quantitative (n = 49), [38-43,45,48-64,66-75,77-91] and approximately 10% (n = 5) utilized mixed methods, containing both quantitative and qualitative aspects.[44,46,47,65,76] The included studies used the following study methods: survey (n = 48),[38-45,48-62,64-67,69-81,84-91] audio-recordings (n = 2),[46,47] audit (*n* = 2),[82,83] audit with interview (n = 1),[63] and observational (n = 1).[68]

Study location included seven high income countries (United States of America,[38,45,49,54,57-59,61,65,71,78,79,86] United Kingdom,[44,48,52,60,74] Australia,[51,75,76,87,90,91] Germany,[81,84] Switzerland,[66] New Zealand,[55,56,80] France, [46]) and three low to middle income countries (Jordan, Argentina, and Urugauy).[28,32,59]

Included studies focused on either HPs (*n* = 39, 72%), [38,39,41,43,44,47-55,57-61,65,66,68-73,75,78-81,83,84,87-91] pregnant women (*n* = 12, 22%),[40,42,45,56,62,63,67,74,76,82,85,86] or both HPs and pregnant women (*n* = 3, 6%).[46,64,77] Studies encompassing HPs included obstetricians and gynaecologists (OBS) (*n* = 9, 21%),[39,49,53,54,57,65,71,73,79] midwives (*n* = 7, 17%),[38,41,51,52,64,72,84] general practitioners (GPs) (*n* = 3, 7%),[60,61,68] multiple professions (e.g., OBS, GPs, nurses, healthcare assistants; *n* = 21, 50%),[43,44,46-48,50,55,58,59,66,69,70,75,77,79-81,87,89-91] or did not report the profession (*n* = 1, 2%).[83]

Out of the 54 papers, information on Ask, Advise, Assess, Assist and Arrange (follow up/referral) was reported by approximately 68%, 70%, 28%, 63%, and 54% of studies, respectively. Few studies addressed all of the 5As combined (*n*=12, 22%). These reported that HPs rarely addressed all of the 5As, e.g. only 19.6% of respondents in Bar-Zeev et al's study of GPs and OBS performed all of the 5As 'often/always'.[91]

Only four studies (7%) addressed the provision of other BCTs in pregnancy. In one study, 31% of OBS advised women to set a quit date;[39] in a second study 29% of midwives suggesting quitting with an acquaintance;[52] 97% of women in a third sample reported they had not had their exhaled carbon monoxide tested,[56] and a fourth study reported which clinics used open-ended questions and problem solving.[89] Additionally, some studies (*n*=12, 22%), obtained information on or addressed a woman's psychosocial context for smoking e.g., family or partner's smoking status or involvement in quitting, a woman's social support, or her living environment e.g., a smoke free home or vehicle (*n*=3, 6%). Information regarding the use of resources was addressed in 20 studies (37%), i.e., providing pamphlets or recommending online programs. Advise about relapse was rarely addressed in the included literature (*n*=3, 6%); e.g. in one of the studies midwives reported they discussed with women how to avoid relapse.[52]

Twenty-nine papers of the 54 papers addressed NRT in some capacity. These included knowledge and training, attitudes to NRT, and prescribing of NRT. Papers addressing knowledge, attitudes and training in general (*n*=14, 26%) also reported on HP knowledge about whether NRT can be used in pregnancy, and HP confidence about their smoking cessation knowledge, awareness of smoking cessation guidelines, knowledge about the consequences of smoking for expectant mothers, and risks to their baby. The majority of HPs believed maternal smoking to be harmful to the fetus and/or the woman, with reports ranging from 90-100%. General knowledge about smoking in pregnancy varied (e.g., in Bonollo et al,[43] only 44-52% of US HPs of various types, had correct knowledge). In Mejia et al's study 75% of Argentinan physicians believed it was safe to smoke up to six cigarettes when pregnant.[69]

In addition, the above group of studies included aspects of smoking cessation training (i.e., whether training had been offered, engaged in, and if more training was needed). In general, HPs reported they had received limited training on smoking cessation care in pregnancy, and identified that they required more training.

Papers including information on NRT prescribing (*n*=14, 26%) reported on the frequency of considering to prescribe NRT, the frequency of recommendation of NRT, frequency of prescribing NRT, percentage of NRT scripts filled by women, percentage following FDA NRT prescription reccomendations, and the different NRT types prescribed (e.g., patches, gum, or inhalators). Overall findings suggested that HPs more often than not chose to not prescribe NRT to pregnant women who smoke, this was also supported by the meta-analysis below.

Attitudes and knowledge was associated with HP practices. In one Australian study, higher levels of knowledge about NRT were associated with greater likelihood of assessing

women's smoking status.[75] In another US study, OBS who perceived NRT as safe to use in pregnancy were 20 times more likely to prescribe NRT.[78] An Australian study determined that HP optimism, and confidence in counselling and/or prescribing NRT, and having sufficient time and resources were associated with a higher performance of all the 5As.[91]

Thirty-three studies were suitable for meta-analysis.[38,39,42,44,45,48,49,51,52,54-58,60,61,65,66,69,71,74-76,78,80,81,84,87,90,92] Seventeen meta-analyses were performed and associated forest plots constructed (see Supplementary File Forest Plot Figures 1 to 17). Figure 2 provides a visual comparison for pooled percentatges of selected categories of 'often/always'.

Overall the performance of 'Ask – often/always' (*n*=9) was 91.6% (95% CI 88.2%, 95%). Percentages for 'Ask – 'always/all'' (*n*=11) was similar at 91.5% (95%CI 85%, 96.3%). Percentages for 'Ask –Yes' (n=4, all by women's report) was slightly higher at 93.6% (95%CI 92.6%, 94.6%).

The performance of 'Advise – often/always' (*n* = 7) was 90% overall (95%CI 72.5%, 99.3%). Percentages for 'Advise – always/all' (*n* = 6) was 86.4% overall (95%CI 79.6%, 93.3%). Percentages for 'Advise – Yes' (HP report) (*n* = 4) was much lower at 58.1% overall (95%CI 55.9%, 60.4%). Percentages for 'Advise – women's report Yes' (*n* = 4) was similar at 53.6% overall (95%CI 52.6%, 54.6%). Percentages for 'Assess motivation to quit – often/always' (*n* = 3) was 79.2% overall (95%CI 76.5%, 81.8%).

Overall 34 manuscripts included a question about assisting. Some were generally asked about assisting the patient to quit, others specified a method of assisting such as counselling, setting a quit date, making a quit plan, and prescribing NRT. Those in the meta-analysis were as follows: 'Assist cessation support – often/always' (*n* =5) was 59.1% (95%CI 56%, 62.2%);

'Assist counselling – yes' (*n*=5) was higher at 80.7% (95%CI 79%, 82.5%); 'Assist quit plan – often/always' (*n*=2) was 57.6% (95%CI 54.1%, 61.1%); 'Assist quit date – often/always' (*n*=3) was low at 29% (95%CI 25.3%, 32.7%); 'Assist – women's report Yes' (*n*=4) was the lowest at 26.8% (95%CI 25.3%, 28.3%). The performance of 'Arrange referral – often/always' (n=6) was 33.3% overall (95%CI 20.4%, 46.2%). There was no analysable data on women's report for 'Arrange'.

'Prescribing NRT – Yes' was 25.4% (*n*=6) overall (95%CI 12.8%, 38%). 'Prescribing NRT – often/always' (*n*=4) however was very low at 12.8% overall (95%CI 10.7%, 15%). The performance of 'Prescribing NRT – always' (*n*=4) was the lowest at 6.2% overall (95%CI 4.9%, 7.4%). There was no analysable data on women's report of having been prescribed NRT. All of the studies in the meta-analysis for 'Prescribing NRT – Yes' were from the USA (Supplementary File Forest Plot Figure 17).

High heterogeneity (I^2 =95.9- 99.1%) was seen for: 'Ask – often/always'; 'Ask – always'; 'Advise – often/always'; 'NRT prescription'; 'Arrange referral – often/always'; thus indicating considerable diversity in study outcomes, methodology, or populations. A fixed effects model was used for the following outcomes due to low number of studies, and heterogeneity was not measured: 'Ask – women's report Yes'; 'Advise – Yes'; 'Assess motivation to quit – often/always'; all the 'Assist' categories; 'NRT Prescription – always', 'NRT Prescription – often/always'.

Table 1 displays the results of the meta-regression of the 'often/always' categories of 'Ask', 'Advise', 'Arrange', and 'Prescribing NRT' from the meta-analysis. 'Assist' only had 5 studies, so the meta-regression was not performed. For nearly all of the measures, none of the

predictors examined significantly explained the heterogeneity of the proportions for the studies. For 'Arrange referral –often/always', country was found to explain some of the differences in proportion of HPs providing this type of smoking cessation care; with Australian and New Zealand studies having significantly higher proportions of HPs reporting 'Arrange referral – often/always' than USA studies (on average). Year was also found to explain some of the differences in proportion with later years having higher proportions of HP reporting this 'Arrange referral- often or always' (on average).

Table 2 shows the quality rating with the Hawker et al tool,[34] for included studies. Over 70% of the studies had some aspects at least that were rated as good, and 20 out of 53 (37.7%) studies that were rated had at least 5 'good' categories out of the 9 available options. Common flaws were lack of clarity about aims, sampling processes not detailed, ethics processes not described, and no suggestions made for further research.

Table 3 shows the quality ratings of the studies, and level of agreement from using the Hawker tool,[34] for the 15 papers that were rated independently by two raters. Coder agreement varied from Poor for two criteria, Fair for four of the criteria, and Moderate for three criteria.

Discussion

This systematic review of 54 studies from 10 countries on a range of HPs who consult with pregnant women who smoke. Thirty-three studies were suitable for meta-analyses for at least one outcome measure. Studies displayed considerable variation in the way they assessed HP provision of each of the 5As. Commonly surveys employed Likert scales that were re-

categorised as 'often or always', or questions forcing a 'Yes/No' option. We pragmatically transformed outcome measures so they could be combined for meta-analysis, over the 5As and their subcategories, resulting in small numbers of studies in each forest plot, which means that interpretations should be cautious. We acknowledge that there was no ideal way to combine these measures. Conceptually, using a scale to quantify responses is quite different from a 'yes' option: the latter may be an option chosen by respondent whether they perform the practice at an frequency from occasionally to always (ie not at all quantified) – therefore we did not combine 'often/always' with 'Yes/No' study measures.

The primary aim to determine the prevalence of the components of SCC that were being practiced by a range of HPs. The review demonstrated several aspects of SCC that could be improved for pregnant women, including those seen in primary care settings. The highest rates were for Ask and Advise, and Assess. Assist and Arrange were consistently lower. Our secondary aim to examine whether SCC differed between different HP types, for pregnant women in high-risk populations, by country, and by year was achieved by meta-regressions of studies reporting practices 'often/always'. Only 'Arrange referral' had a significant result, indicating that year and country could explain some of the heterogeneity, and perhaps indicating an increased awareness of referral options in later years, or in Australia and New Zealand. The 21 studies not included in the meta-analysis, revealed few comparable quantitative studies on HP knowledge, attitudes and the lesser reported practices of BCTs, and the implementation of all components of the 5As together. On the whole HP knowledge base might be insufficient about NRT. Poor understanding about the safety or efficacy of NRT in pregnancy compared to continued smoking may lead to under-prescribing of NRT as a stop smoking aid, however this is likely to be context sensitive as not all countries recommend the use of NRT and clinical guidelines vary across time and even within the same

country.[17] However, all of the studies in the meta-analysis of NRT were from the USA, and considerable variation for prescribing NRT is seen within that one country. Access to HP training for SCC was reported as being limited, and HPs indicated they required more training.

The strength of this study is that, as far as we are aware, it is the broadest and most rigorous systematic review of HP performance of the 5As in pregnancy, including 7 high-income and three low to middle income countries and the only review, to our knowledge, to perform a meta-analysis and meta-regression. We took care to combine outcome measures with like measures, for each of the 5As, wherever possible. Multiple meta-analyses were performed, for each combined measure. The high heterogeneity suggests a cautious interpretation of the results. The review was limited by not being able to determine the cause for the high heterogeneity in the meta-analyses by our meta-regression, except for 'Arrange referral-often/always' which was related to year, and country. We recognise that differing clinical guidelines may have impacted the provision of NRT in pregnancy in some countries. In particular NRT is not recommended for pregnancy in the USA. Additionally, while most countries do use the 5As, there are variations, such as ABC (Ask, Brief Advice, Cessation) in NZ, and Ask, Advise, Action (AAA) in the UK. These have in common the first 2As, and then a variation to shorten the mnemonic or practice. This variation may be a limitation to this study.

Where the number of studies was low (≤5), fixed effects modelling was used because the between-studies variance (tau-squared), and therefore the mean of the underlying random distribution cannot be estimated with precision; heterogeneity is also not presented in these cases. We suggest these results are interpreted with caution, and consideration be given

to the degree of overlap in the study specific confidence intervals. The quality rating revealed aspects of some papers were poor; findings from these studies may be less reliable. However unresolved discrepancies between the raters indicate a circumspect interpretation.

Two other reviews examined the provision by HP of SCC for pregnant women. Okoli et al's non-systematic review included 28 studies from 6 high-income countries (USA, Australia, UK, Germany, Canada, and the Netherlands).[27] The review reported that few HPs working with pregnant women use all the components of the 5As. Although more than 50% of HPs in the review asked women about their smoking status and advised pregnant smokers to quit, fewer than 50% assessed motivation, assisted smoking cessation, or arranged follow-up or referrals. Our review highlighted the diversity of the ways different studies surveyed HPs about their use of the 5As, but it is unclear from the Okoli review how these estimates were made. Instead a range was reported for each of the 5As, (for example 'Ask' 73-100%; 'Assess' readiness or willingness to make a quit attempt 42-81%) without the reader being able to determine which studies used Likert scales, if measures were re-categorised, or a dichotomous Yes/No employed. Baxter et al's systematic review included 23 papers from 6 high-income countries, one middle-income country (UK, France, Sweden, USA, Australia, NZ, South Africa) and one multi-nation study, in a qualitative synthesis.[28] Similarly, although Baxter's review reports percentages of HP or women giving or receiving different aspects of the 5As, they do not describe how these questions were asked.[28]

The low rates of reported implementation of components of the 5As may be related to barriers at several levels. Okoli et al's review suggests several important provider-specific, patient-specific, and system or organizational barriers hindering the provision of SCC by HP.[27] Provider-specific barriers centred around HP self-efficacy or perceived ability to provide SCC to pregnant smokers, namely low knowledge, low confidence for counselling

and use of NRT, the perception that as HPs they could not influence the patient's smoking behaviour, or that SCC was not their role. In the studies in our review, HP practices also related to HP knowledge and attitudes (optimism and confidence). Patient-level barriers included HP perceptions that pregnant smokers were not interested in quitting, had stressful lives, and HPs not wanting to jeopardise their relationship with the pregnant patient by raising smoking as an issue. System-level barriers included lack of time, resources, training and protocols, similarly described in our review. Baxter et al's review also reports barriers to providing SCC: discussing smoking cessation depended on whether HPs were able to broach the subject, staff confidence and perception of effectiveness, manner of communication, whether follow-up occurred, time and resource constraints, and service protocols.[28]

One of the included Australian studies explained some of the factors that may impinge on the quality of SCC for pregnant women. Bar-Zeev et al analysed the factors associated with performance of the 5As, and provision of NRT in Australian medical practitioners.[91] In a national study of 378 GPs and OBS, 'internal influences' (including HP confidence for counselling and prescribing NRT, optimism, sufficient time and resources) were associated with a higher likelihood of performing the 5As, whereas 'external influences' (i.e., workplace routines, doctor-patient relationship, comfort raising the issue, perceived priority) were associated with performing the shorter version of Ask, Advise, Refer (AAR).[91,93,94] Furthermore, being an OBS compared to being a GP, low confidence, and uncertainty about safety of NRT, were associated with lower odds of prescribing NRT.[92]

Our objective to determine which aspects of SCC for pregnant women could need improvement, revealed on the whole that 'Assist' and Arrange' were less performed. Assisting pregnant smokers to quit is a vital priority. Unless there are high-quality specialised

services to refer pregnant smokers to, it is insufficient for HPs to raise the issue, advise, and assess, without going further to actually assist a quit attempt, and as a duty of care arrange follow up or referral. Psychosocial support coupled with NRT (if needed, available and approved) may give pregnant women the best chance of quitting.[17,95] Various implementation strategies could be considered to improve SCC delivery to pregnant women, which may include HP education and training, promotion of clinical practice guidelines, audit and feedback, reminders, opinion leaders, incentives, or supervision.[96] Training was reported as an educational need by the HPs in the studies, and worthy of consideration. Training should most urgently focus on the elements of the 5As that are seldom performed, taking into account country-specific needs and guidelines. Training should provide actual skills to HPs in how to assist smokers to quit, and give opportunities to practice and receive feedback on their performance. Evidence-based updates on the use of NRT in pregnancy may be warranted especially if professional college guidelines are not up-to-date, with a caution about jurisdictions that may deter prescribing or access.[17]

Providing access to resources, such as educational and training materials for HPs, evidence-based and culturally-appropriate patient information sources, and affordable NRT, will demand changes to policy in some settings and countries. Time is a perennial problem for HPs, however changes in practice protocols, and a whole-of-service approach, could support pregnant women to receive the time investment warranted by such an important issue for their own and their baby's health. Additionaly, policy changes to provide accessible and culturally-appropriate referral options are critical. Further research is warranted to understand which interventions can successfully improve HP performance of the 5As, and whether other models, such as the AAR,[96] the ABC (Ask, Brief Advice, Cessation),[97] or ABCD (Ask, Brief Advice, Cessation, Discuss)[98] approach may better facilitate HP implementation of SCC, and

correspondingly improve quit rates in pregnant women. Standardised methods to assess the provision of SCC and the 5As in research or program evaluations, would aid future comparisons.

Conclusions

In a systematic review of HPs' provision of SCC for pregnant women in 10 countries, meta-analyses were performed after combining like measures across studies where feasible. Pooled percentages revealed that HPs reliably 'Ask', 'Advise' and 'Assess' pregnant women about tobacco smoking. 'Assist', including assist by 'prescribing NRT', and 'Arrange referral' were much lower, and may be improved by appropriate interventions such as training, incentives or prompts. Meta-regressions were significant only for 'Arrange referral' for year and country. Further research may be required to understand other factors driving the heterogeneity between different studies. Standardised methods to assess the provision of SCC and the 5As are warranted.

Author Statement: GSG was responsible for the design of the review, publishing the protocol in PROSPERO, oversaw all aspects of the study and wrote the manuscript. LT conducted the searches with YB. LS did the data extraction, and with YB the quality analysis. KP conducted the meta-analyses and meta-regressions. GRG assisted GSG in writing the methods and results sections, and preparing tables. BB advised on study design and critically reviewed the manuscript. YBZ advised on manuscript drafts as senior author. All authors reviewed and approved the final manuscript.

Declaration of interests

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Figure Legends:

Figure 1: Prisma Flow Chart of included studies

Figure 2: Comparison of pooled percentatges of selected categories of 'often/always'

Tables

Table 1: Meta-regression analysis of HP practices performed 'often/always'

Predictors	ASK	ADVISE	ASSIST	ARRANGE	NRT
N studies	9	7	5***	6	6
No predictors					
I^2 resid	96%	91.9%	72.9%	95.9%	97%
τ^2	0.008	0.0304	0.003	0.019	0.017
Provider type					
p-value	0.18	0.487	0.134	0.898	0.304
I^2 resid	95.6%	87.7%		97.4%	94.8%
τ^2	0.006	0.031		0.029	0.013
High risk					
p-value	0.909	**	0.43	0.62	**
I^2 resid	96.4%			96.7%	
τ^2	0.009			0.021	
Country					
p-value	0.845	0.252	0.185	0.037	0.903
I^2 resid	96.5%	89.4%		84.5%	97.6%
τ^2	0.012	0.022		0.006	0.021
Year					
p-value	*	*	*	0.013	*
r^2 resid				73.9%	

** non-linear, model not performed, ** no high risk populations, ***too few studies, I2 and τ^2 not available*

Table 2: Quality assessment of 54 included studies

Author (year)	Abstract and title	Intro and aims	Method and data	Sampling	Data analysis	Ethics and bias	Results	Transferability	Implications and usefulness
Abatemarco (2007)	Good	Good	Fair	Good	Fair	Fair	Poor	Good	Good
Amarin (2005)	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor	Fair
Bakker (2005)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair
Bar Zeev (2017)	Good	Good	Good	Good	Fair	Fair	Good	Fair	Good
Beenstock (2012)	Good	Good	Good	Good	Good	Fair	Good	Good	Good
Berruetas (2016)	Fair	fair	Fair	Good	Fair	Fair	Good	Good	Good
Bonollo (2002)	Good	Good	Good	Fair	Good	Good	Fair	Fair	Fair
Bull (2006)	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Good
Castrucci (2006)	Fair	Fair	Fair	Fair	Fair	Very poor	Fair	Fair	Fair
Chang (2008)	Good	Good	Good	Fair	Fair	Good	Fair	Fair	Fair
Chang (2013)	Fair	Good	Good	Fair	Good	Good	Fair	Fair	Good
Clasper (1995)	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Coleman-Cowger (2014)	Good	Fair	Good	Good	Fair	Very poor	Fair	Fair	Good
Condliffe (2005)	Good	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair
Cooke (1996)	Good	Fair	Fair	Good	Good	Fair	Good	Good	Good

Cooke (1998)	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair
Eiser (1999)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair
England (2014)	Good	Good	Fair	Good	Good	Good	Good	Good	Good
Floyd (2001)	Fair	Fair	Fair	Poor	Fair	Fair	Fair	Poor	Fair
Glover (2008)	Fair	Fair	Poor	Fair	Poor	Fair	Fair	Fair	Fair
Grange (2006)	Poor	Fair	Poor	Fair	Fair	Poor	Fair	Fair	Fair
Grimley (2001)	Good	Good	Good	Good	Fair	Good	Good	Fair	Good
Hartmann (2007)	Good	Good	Good	Fair	Fair	Good	Good	Fair	Fair
Helwig (1998)	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Herbert (2005)	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Hickner (1990)	Fair	Poor	Fair	Fair	Fair	Poor	Fair	Fair	Fair
Hoekzema (2014)	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair
Howard (2013)	Good	Good	Good	Good	Good	Good	Good	Fair	Good
Jones (2003)	Good	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Jordan (2006)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Good
Lemola (2012)	Good	Good	Good	Good	Good	Fair	Good	Good	Good
Mabbutt (2002)	Good	Good	Fair	Poor	Fair	Fair	Good	Poor	Fair
McEwen (2003)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mejia (2010)	Good	Fair	Fair	Good	Fair	Poor	Fair	Fair	Good
Moran (2003)	Fair	Good	Good	Good	Good	Poor	Good	Good	Good
Mullen (1998)	Fair	Good	Fair	Fair	Good	Poor	Fair	Fair	Fair
Murphy (2016)	Fair	Fair	Fair	Good	Fair	Good	Fair	Good	Good
Oncken (2000)	Good	Fair	Good	Good	Good	Poor	Good	Good	Fair
Owen (1999)	Poor	Fair	Poor	Very poor	Poor	Poor	Poor	Fair	Fair
Passey (2012)	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Good
Passey (2015)	Fair	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair
Passey (2014)	Fair	Fair	Fair	Fair	Good	Fair	Good	Fair	Good
Price (2006)	Good	Fair	Good	Fair	Good	Poor	Good	Fair	Good
Price (2006)	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair
Pullon (2004)	Fair	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair
Roske (2009)	Good	Good	Fair	Good	Good	Fair	Good	Good	Fair
Solberg (2010)	Good	Good	Good	Good	Good	Good	Good	Good	Good
Tappin (2010)	Fair	Fair	Fair	Good	Poor	Fair	Fair	Fair	Fair
Thyrian (2006)	Good	Good	Good	Good	Good	Good	Good	Good	Good
Tong (2008)	Good	Good	Fair	Good	Fair	Poor	Fair	Good	Fair
Tran (2010)	Good	Fair	Good	Good	Good	Fair	Good	Good	Good
Tzelepis (2017)	Good	Fair	Good	Good	Good	Good	Good	Good	Good

Walsh (1995)	Good	Fair	Good	Fair	Fair	Fair	Good	Fair	Fair
Zapka (2000)	Good	Fair	Good	Fair	Good	Fair	Good	Fair	Fair

NA – not applicable as was a letter to the Editor

Table 3: Findings from agreement of quality rating analysis of coders using the Hawker tool

	Mean Rating (SD) 1 (very poor) to 4 (good)		*Agreement*	
Study Criteria	***Rater 1***	***Rater 2***	***Weighted kappa (95%CI)***	***Agreement***
Abstract and title	2.4 (0.6)	2.3 (0.6)	0.13 (-0.41, 0.68)	Poor
Intro and aims	2.3 (0.5)	2.1 (0.3)	0.25 (-0.17, 0.67)*	Fair
Method and data	2.2 (0.6)	2.3 (0.6)	-0.15 (-0.74, 0.43)	Poor
Sampling	2.1 (0.8)	2.3 (0.6)	0.43 (0.10, 0.76)	Moderate
Data analysis	2.1 (0.6)	2.1 (0.5)	0.51 (0.03, 0.99)	Moderate
Ethics and bias	1.9 (0.8)	1.9 (1.0)	0.38 (0.13, 0.63)	Fair
Results	2.3 (0.7)	2.4 (0.5)	0.26 (-0.11, 0.62)	Fair
Transferability	2.2 (0.4)	2.3 (0.6)	0.21 (-0.19, 0.61)	Fair
Implications and usefulness	2.4 (0.6)	2.5 (0.6)	0.58 (0.18, 0.98)	Moderate

*only 2 levels, therefore Kappa rather than weighted Kappa used

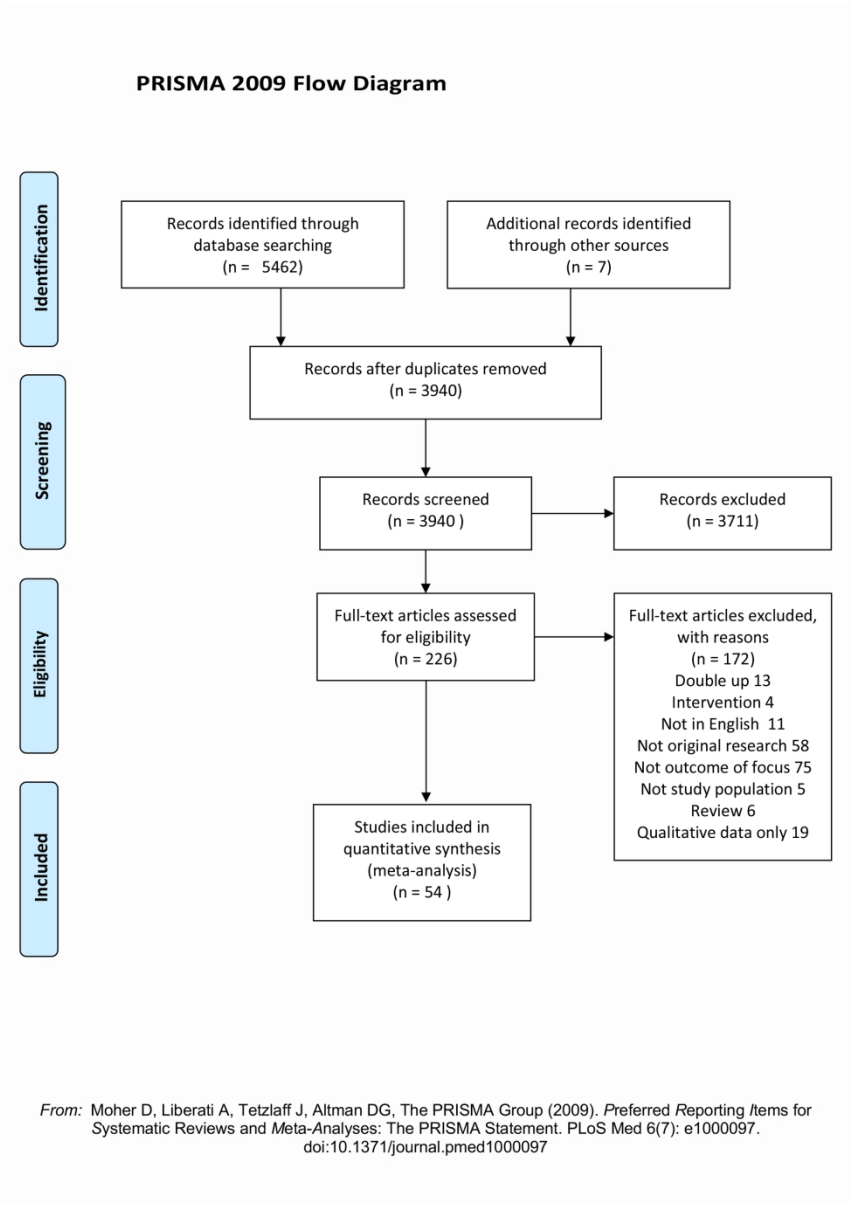


Figure 1: Prisma Flow Chart of included studies

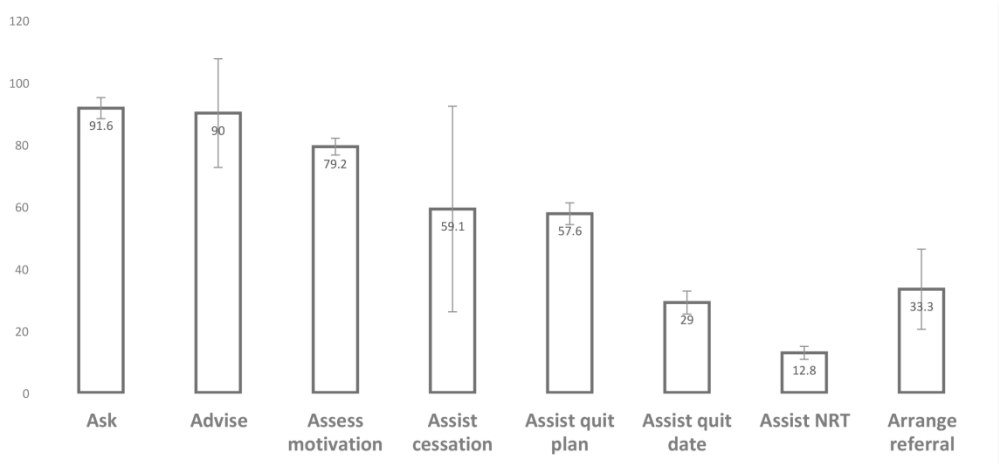


Figure 2: Comparison of pooled percentatges of selected categories of 'often/always'

Supplementary Table 1: Key search terms for systematic review on Health Providers' Practices for Smoking Cessation Care in Pregnancy

Health Professional	Attitudes and Practices	Smoking	Pregnancy
Allied health personnel	Health Knowledge, Attitudes, Practice	Tobacco dependence treatment	Maternal behaviour
General practitioner	Attitude of Health Personnel	Maternal tobacco smoking	Perinatal Care
Medical practitioner	Knowledge	Smoking Cessation	Pregnancy
Health Professional	Perception	Tobacco use disorder	Maternal
Health personnel	Practice	Nicotine dependence	Mother
Family Practice	Belief	Smoking treatment	Preg*
Specialist	Capacity	Smoking	Antenatal
Physician	Capability	Smok*	
Doctor	Confidence	Tobacco	
Midwife	Priority		
Gynaecology	Barrier		
Obstetrics	Attitude		
Clinician	Skill		
Dentist	Ability		
Pharmacist			
Consultant			

Note: all search terms were "exploded", meaning the terms underneath these keywords were also searched for.

Supplementary Table 2: Characteristics of included quantitative (N=54) studies

First Author (year) Country	Study Focus	Population & Risk Category (high/low)	Study Aim(s)	Ask	Advise	Assess	Assist	Arrange follow up	NRT	Summary of results
Abatemarco (2007) USA	Health Providers (Midwives)	Low risk	Determine how New Jersey's certified nurse-midwives (CNMs) provide tobacco screening and cessation counselling to pregnant smoking women.	X	X	X	X	X		Nearly all midwives routinely ask, advise, and assess; while fewer address quit dates, or discuss medication options (assist) and perform follow-up activities (arrange). Midwives identify a need for training.
Amarin (2005) Jordon	Health Providers (Obstetrician & Gynaecologists)	Low risk	Establish tobacco use amongst obstetricians/gynaecologists and assess awareness of the impact of smoking on health; routine practices with patients who smoke; opinions of factors contributing to tobacco use and their perceived barriers to counselling improvements.	X	X		X			A high proportion of obstetricians/gynaecologists are smokers. Most health professionals associated smoking with low birth weight and sudden infant death syndrome. Fewer associated smoking with infertility, ectopic pregnancy, placenta praevia, abruption placentae and cancer of the uterine cervix. Friends, stress, parents' attitude, genetic predisposition, income and education were implicated factors for smoking. Current smokers were more likely to permit smoking in their practices. Non-smokers were most inclined to record their patients' tobacco habits. Only 54.3% provided cessation counselling. Lack of time and inadequate training were perceived barriers.
Bakker (2005) Netherlands	Pregnant Women	Low risk	To identify relevant factors that hamper or promote the provision of effective smoking cessation advice and counselling.			NA*				In general, midwives were motivated to provide their clients with smoking cessation advice, however, were less comfortable guiding women through the cessation process.
Bar-Zeev (2017) Australia	Health Providers (GPs & Obstetricians)	Low risk	Examine: 1) Self-reported provision of SCC to pregnant women by GPs and Obstetricians in Australia; 2) Barriers and enablers to SCC and 3) Associations between	X	X	X	X	X	X	Almost all clinicians (98%) reported that addressing smoking during pregnancy is a high priority, and that they feel comfortable raising the issue with a pregnant woman (95%). TDF statements receiving the lowest agreement(agree & strongly agree) were having sufficient time (41%), sufficient resources (47.5%) and optimism of intervention effectiveness (35%). Dimension reduction revealed two factors: 1) 'Internal influences' including confidence in counselling, confidence in prescribing NRT, optimism, sufficient time and resources; 2) 'External influences' including high priority, benefit relationship,

			health professionals (GP/Obstetrician), knowledge, attitudes, and performance of SCC."						workplace routine, and comfortable raising the issue. Compared to NFASTIH GPs, being an Obstetrician was associated with lower performance of all the 5A's, but with a higher performance of AAR. No difference was found between the performance of the RANZCOG GPs and Obstetricians. 'Internal influences' were associated with a higher performance of all the 5A's, whereas 'External influences' were associated with a higher performance of AAR. Performing all the required 5A's was done by less than 20% of participants and was associated with barriers that are internal such as low confidence and low optimism. Internal barriers includes confidence in counselling, confidence in prescribing NRT, optimism in intervention effectiveness, sufficient time and resources. External barriers includes high priority, benefit relationship, workplace routine, comfortable raising the issue.
Beenstock (2012) UK	Health Providers (Midwives)	Low risk	Investigate the perceived implementation difficulties of midwives in providing smoking-cessation advice to pregnant smoking women. Investigate relationships between the self-reported behaviour of referring women to smoking-cessation services and demographic and professional variables.			NA*			Midwives were less certain about the consequences of, and the environmental context and resources available for, engaging in this work relative to other TDF domains. The 'propensity to act' was predictive of the self-reported behaviour 'Refer all women who smoke.....to NHS Stop Smoking Services' and mediated the relationship between demographic variables (e.g., midwives' workplace and behaviours). This study supports previous research that the TDF is an appropriate tool to understand the behaviour of healthcare professionals.
Berruetas (2016) Argentina & Uruguay	Pregnant Women	High Risk-Economic-ally deprived	Assess smoking patterns and receipt of 5A's among pregnant women in Buenos Aires, Argentina and Montevideo, Uruguay.	X	X	X	X	X	Among pregnant smokers in Argentina, 23.8% reported that a provider asked them about smoking at more than one prenatal care visit; 18.5% were advised to quit; 5.3% were assessed for readiness to quit, 4.7% were provided assistance, and 0.7% reported follow-up was arranged. In Uruguay, those percentages were 36.3%, 27.9%, 5.4%, 5.6%, and 0.2%, respectively.
Bonollo (2002) USA	Health Providers (Physicians, Nurses, Practitioner, & Nutritionists)	Low risk	To examine in detail the specific content and levels of knowledge among providers caring for low-income pregnant and postpartum women to present a current perspective on counselling related to tobacco addition. Explore provider characteristics related to knowledge levels.			NA*			Providers reported low awareness of the health risks of smoking to the developing foetus/child of pregnant and postpartum women and of the effectiveness of nicotine replacement therapy (NRT) for doubling quit rates. Obstetric (OB) and WIC providers were more aware than PED providers that provider-delivered interventions are effective. Confidence in using counselling steps was significantly associated with general and NRT-related knowledge. NRT-related knowledge, but not general knowledge, was associated with higher performance of intervention steps. Educational programs targeting OB, WIC, and PED providers' knowledge about effective smoking cessation counselling strategies and their confidence in being effective with patients are needed.
Bull (2006) UK	Health Providers (Health Visitors, Midwives, And Nurses)	Low risk	To examine the attitudes, knowledge and practice of health visitors, midwives and practice nurses in relation to smoking cessation interventions with	X	X	X	X	X	All health practitioners claimed to ask if their patients smoked. Most claimed to record smoking status on health records and give cessation advice. Fewer provided advice to partners of women in their care and only a minority had read the NICE clinical guidelines on NRT.

			pregnant women and new parents.							
Castrucci (2006) USA	Pregnant Women	Low risk	Describe the range of risk reduction behaviours among women who continue to smoke after learning of their pregnancy, including reduce tobacco use, eventual cessation and sustained abstinence as well the patient-reported smoking cessation - promoting behaviours of prenatal care providers.				X	X		Smoking cessation was achieved by only a quarter of antenatal smokers, almost 90 percent reduced their cigarette consumption. Antenatal smokers reported that prenatal care providers asked about their smoking (90.6%) and advised about quitting (76.5%). However, only 27.9% were given referrals to smoking cessation programs.
Chang (2008) USA	Pregnant Women & Health Providers (Obstetrics-Gynaecology Resident, Nurse Midwife, & Nurse Practitioner)	Low risk	Examine patient-provider communication about substance use behaviours during obstetric visits.	X	X	X	X	X		Provider responses to smoking disclosures included discussions of risks, encouragement to quit-cut down, affirmation of attempts to quit-cut down, and referral to smoking cessation programs. Providers should discuss behavioural change strategies and motivations with pregnant patients who use substances.
Chang (2013) USA	Health Providers (Nurse Midwife, Nurse Practitioner, Residents, Physician Assistant)	Low risk	Describe obstetric providers' adherence to the evidence-based clinical practice guideline for smoking cessation counselling, the 5 A's (Ask, Advice, Assess, Assist, and Arrange).	X	X	X	X	X	X	Obstetric providers frequently asked about smoking (98%) however, used 3 or more of the 5 A's in only 21% (24) of visits. In no visits did providers use all 5 A's.
Clasper (1995) UK	Health Providers (Hospital Midwives, Community Midwives, General Practitioners, Obstetricians)	Low risk	To inform the development of future smoking cessation interventions in pregnancy by measuring current practice and the associated attitudes and beliefs of the main professionals responsible for the delivery of antenatal care.	X	X		X	X		Most professionals asked about the smoking status of pregnant women, record smoking status and explain the risks of smoking while pregnant. Fewer professionals gave pregnant smokers advice on how to stop or monitored at and reviewed smoking status throughout pregnancy. Most experienced difficulty and a lack of enjoyment while giving smoking cessation counselling. Over half (53%) perceived themselves to be insufficiently trained, whilst few (28%) thought that they possessed the necessary skills.
Coleman-Cowger (2014) USA	Health Providers (Obstetrician & Gynaecologists)	Low risk	To assess current ob-gyn practice patterns related to the management of and barriers to smoking	X	X	X	X	X	X	Ob-gyns estimated that approximated that 32% of pregnant smokers quit during pregnancy, but 50% return to smoking postpartum. The primary barrier was time limitations. Compared with findings from a similar study conducted in 1998, physicians are less likely to adhere to the 5 As smoking cessation guideline at present.

			cessation during pregnancy and postpartum.						
Condliffe (2005) USA	Health Providers (Midwives Grandes E-H, Health Care Assistants)	Low risk	Explore the self-reported smoking-cessation interventions of maternity staff with pregnant smokers and their attitudes towards smoking in pregnancy.		X	X		X	Over two-thirds of respondents (71%) reported not advising any pregnant women to give up smoking within the previous 7 days. However, 64% felt women should not make up their own minds about whether to smoke during pregnancy, and 81% agreed/strongly agreed that many pregnant women would like to give up smoking but need help and advice on how to succeed. Helping a pregnant woman to give up smoking was seen as being one of the most important things a midwife can do by 73% of the respondents. Although the reported attitudes were supportive of the midwife's role in smoking cessation, they did not translate into practice. The level of smoking cessation interventions was low.
Cooke (1996) Australia	Health Providers (Midwives)	Low risk	Assess current practice in smoking cessation interventions by midwives and to examine the relationship between the use of smoking interventions, practitioner's characteristics, and organisational factors.	X	X		X	X	Most midwives used minimal interventions (advice and education) for at least some of their clients. The more skilled and more time-intensive forms of intervention (e.g., counselling, negotiating a quit date, and follow-up) were infrequently utilized. Participants estimated that half their smoking clients were not offered advice about smoking. Organizational factors such as: hospital policy for smoking intervention, type of hospital, size of hospital, cohesion of staff and work pressure predicted the use of smoking interventions. Self-reported ability to intervene for smoking and the level of assessment undertaken were practitioner characteristics which predicted the use of smoking interventions. The barriers that inhibit the use of smoking intervention by midwives are discussed and methods for change canvassed.
Cooke (1998) Australia	Health Providers (Midwives, Doctors: Obstetric Specialists, Registrars and Residents)	Low risk	The aims of the study were to describe the smoking intervention practice of antenatal clinic staff, and to ascertain the organizational and practitioner variables which predict clinician use of smoking interventions.	X	X		X	X	Most antenatal clinic staff did not use the most effective forms of brief interventions for smoking. The presence of specific procedures and training in smoking cessation intervention appeared to be the most important predictors of reported smoking intervention in hospital antenatal clinics.
Eiser (1999) UK	Health Providers (Midwives)	Low risk	Assess a) their attitudes to giving anti-smoking advice to pregnant smokers and whether they perceived this as part of their professional role and b) the types of advice they gave to pregnant smokers as part of their routine practices.	X	X	X	X		Midwives attitudes towards giving anti-smoking advice were generally positive, and almost all reported routinely explaining the health dangers of smoking to pregnant smokers. Among midwives who had never smoked, those who held role attitudes that were more favourable towards anti-smoking intervention reported providing relatively more advice based on warnings of health consequences and an emphasis on abstinence. Among the remainder of the sample, more favourable attitudes predicted greater use of behaviourally-oriented advice to facilitate cessation or smoking reduction, but were unrelated to the use of health warnings and emphasis on abstinence.
England (2014) USA	Health Providers (Obstetrician-Gynaecologist Physicians)	Low risk	Examine screening practices and attitudes of obstetricians-gynaecologists toward new and emerging tobacco products.			NA*			A substantial proportion of obstetrician-gynaecologists reported never or inconsistently screening their pregnant patients for the use of non-combustible tobacco products. Responses regarding the harms of these products relative to cigarettes were mixed and most respondents wanted more information.

Floyd (2001) USA	Health Providers (Obstetric-Gynaecologists)	Low risk	Assess the knowledge, beliefs and practice behaviours of obstetricians/ gynaecologists concerning their patients prenatal use of tobacco and other drugs.	X	X		X	X	X	While screening of prenatal patients for tobacco use and other drug use was reported by survey respondents, providing or arranging for interventions for those screening positives was less often reported.
Glover (2008) NZ	Health Providers (GPs, Registered Midwives)	Low risk	To examine New Zealand general practitioners' GP and midwives' smoking cessation knowledge and support offered to pregnant women who smoke.	X	X	X	X	X	X	GPs are in the ideal position to offer stop-smoking advice, because they usually confirm pregnancy. GPs are most likely to advocate stopping smoking completely; midwives are more likely to advocate cutting down with a view to quitting. Both GPs and midwives would benefit from improved knowledge of the full range of nicotine replacement therapy (NRT).
Grange (2006) France	Pregnant Women	Low risk	To describe the management of tobacco withdrawal in pregnant women.	X	X	X	X			Healthcare professionals seems to offer only rudimentary care. Simple strategies to help women give up smoking are required. The partner is an important target, especially if he can be persuaded to give up at the same time.
Grimley (2001) USA	Health Providers (Obstetrician & Gynaecologists)	Low risk	To determine the adherence to the clinical guidelines for smoking cessation among Ob-gyn physicians within Alabama.	X	X	X	X	X	X	Interventions are needed to motivate, support, and guide OB-GYN physicians to assist and follow-up with their pregnant patients who smoke.
Hartmann (2007) USA	Health Providers (Obstetricians, Midwives, Family Medicine Physicians, Nurse Practitioners and Physician Assistants)	Low risk	To measure the use of best practice intervention including each of the 5 A's and to assess the relationship between best practice and current intervention resources, prior training in smoking cessation intervention and barriers to providing intervention.	X	X	X	X	X	X	Best practice is well-established to promote prenatal smoking cessation yet implemented by only one third of prenatal care providers in North Carolina. In this study, best practice was associated with resources, practice organization, and reimbursement. Augmented use of available resources (e.g., toll-free hot-lines) and adequate reimbursement may promote best practice implementation.
Helwig (1998) USA	Health Providers (Obstetricians, Family Physicians, Midwives)	Low risk	Investigate the usual intervention practices of family physicians, obstetricians, and nurse midwives for their patients who smoke.	X			X	X	X	Maternity care providers underutilize effective methods of smoking cessation for their patients who smoke and rely on less effective methods.
Herbert (2005) UK	Health Providers (GPs)	Low risk	Determine a). General practitioners' confidence in their ability to deliver a range of smoking cessation interventions, including NRT in pregnancy, b). the frequency with which general practitioners recall prescribing NRT in		X			X	X	Most general practitioners (62%) believed NRT to be effective in pregnancy and safer than smoking (70%), but fewer (45%) believed NRT to be safe in pregnancy. GPs who believed NRT use in pregnancy was safer than smoking were most likely to recall having prescribed it. Many general practitioners were unsure about the safety of NRT in pregnancy. The key factor influencing general practitioners' prescribing decisions was a belief that NRT use in pregnancy was likely to be safer than smoking.

			pregnancy and c). The factors that influence general practitioners to prescribe NRT in pregnancy.						
Hickner (1990) USA	Health Providers (Family Physicians)	Low risk	Reports practitioner's attitudes and strategies towards antismoking interventions for pregnant smokers.	X	X	X	X	X	Most physicians routinely assessed smoking status at the first prenatal visit, and advised pregnant smokers to quit smoking during pregnancy. The most frequently used method of intervention was personal counselling (97%), referral to smoking cessation clinics (40%), and behaviour modification (20%). Fifty-seven percent of physicians reported using antismoking pamphlets, and 30% used antismoking posters. 97% were convinced that the benefits of smoking cessation during pregnancy merited their efforts.
Hoekzema (2014) Australia	Pregnant Women	Low risk	To characterise pregnant smokers and to understand their smoking behaviours and preferences for smoking cessation. The specific objectives were to study the smoking patterns, smoking cessation and treatment preferences of pregnant women and to investigate the scope for a smoking cessation program in the antenatal settings.		X	X		X	There were 87 (69.6%) daily smokers and 38 (30.4%) occasional smokers. Smokers mainly had medium (54; 43.2%) or heavy nicotine dependence (45; 36%). Current smokers were younger, Australian born, not living with a partner, from a lower socio-economic background, multigravida and had a smoker in their household or among friends. Although pregnant smokers were aware of the possible complications of smoking, their motivation and confidence to quit (median) on a 10-point scale were 7 and 4, respectively. Most smokers preferred to stop smoking gradually (74; 71.2%). The preferred methods for quitting were medications (49; 47.6%) and hypnotherapy (35; 34.0%). Patches (28; 29.5%) were the preferred dosage form, and nicotine replacement therapy (25; 28.1%) was the preferred medication. Less than half reported that their health professionals discouraged smoking during pregnancy.
Howard (2013) UK	Pregnant Women	High risk – women with mental illness	Investigate whether pregnant women with mental disorders: a). Are less likely to accept referrals to smoking cessation services, b) are less likely to stop smoking by delivery, and c). Differ in their experiences of smoking, smoking cessation and smoking cessation services compared with pregnant women without mental disorders.			X	X		Pregnant women with mental disorders appear more motivated, yet find it more difficult, to stop smoking. Prioritisation of mental health over smoking may thus lead to increasing health inequality for this group.
Jones (2003) UK	Pregnant Women & Health Providers (Midwives)	Low risk	Explore the attitudes of midwives and pregnant women towards smoking cessation advice to understand why it is not a routine part of antenatal care.		X	X			Only 45% of midwives offered smoking cessation advice routinely, although 82% felt it should be a part of the antenatal care (82%). Lack of time (66%) and training (54%) were the major reasons for this. Smoking cessation advice was not a priority for discussion among the midwives compared to topics such as antenatal screening or place of delivery. Women were aware of the dangers of smoking in pregnancy, but those who wanted to quit need more support from their midwives (83%). They ranked smoking cessation as a

										high priority for discussion at the antenatal visit. The midwives did not feel able to offer smoking cessation advice. The main reason being a of lack of time in the antenatal clinic.
Jordan (2006) USA	Health Providers (Obstetricians, Gynaecologist)	Low risk	To assess Ohio obstetrician/gynaecologists' perceptions and use of the 5A's methods of smoking cessation with pregnant patients who smoking.	X	X	X	X	X	X	Obstetrician/gynaecologists face many competing demands for their time and energy, yet 62% believed smoking cessation advice would be of significant value. Physicians with higher levels of efficacy expectations reported significantly greater use of the 5 As. Future research should explore ways to facilitate obstetrician/gynaecologists' use of the 5As method.
Lemola (2012) Switzerland	Health Providers (Gynaecologists, Midwives)	Low risk	Examined whether gynaecologists and midwives engage in screening and counselling of pregnant women and conducting interventions to prevent smoking during pregnancy. Examine control beliefs involving efficacy expectations of practitioner.	X	X		X			Most gynaecologists and midwives reported screening all pregnant patients regarding smoking, explaining the risks and recommending smoking cessation. By contrast, only a minority engages in more extensive prevention efforts. Strong control beliefs were predictive of a higher likelihood of screening and counselling, as well as of engaging in more extensive interventions.
Mabbutt (2002) Australia	Pregnant Women	Low risk	To examine substance use among pregnant women and their partners, to record changes in reported substance use during pregnancy and to determine what advice they received to stop smoking.		X					Routine advice to quit smoking was not the norm for this group who were motivated to attend antenatal classes and possibly more likely to act on quit smoking advice. Of the women and men who did receive advice to quit smoking, the majority of this advice was not from a health professional. Routine advice about quitting smoking should be a mandatory part of antenatal care, especially for disadvantaged groups, where smoking rates are higher. The antenatal setting accesses most pregnant women and provides a population base for comprehensive anti-smoking strategies for them and for their partners. Failure to implement such strategies would be to miss the opportunity for a cost-effective and disseminable public health intervention for pregnant women and their male partners.
McEwen (2003) UK	Health Providers (GPs)	Low risk	Investigate methods of early referral of pregnant smokers.	X				X		From a total of 55 GPs, in 17 practices within a deprived area of South West London, according to predictions from the delivery figures for the previous year, approximately 120 pregnant smokers should be identified within the 9-month period that the study took place. GPs were invited to use whatever form of referral was most convenient to them. Only 8 referrals were received.
Mejia (2010) Argentina and Uruguay	HEALTH PROVIDERS (Obstetricians, Gynaecologists, & Residents)	Low risk	To describe physicians' practices of smoking cessation and second-hand smoke exposure counselling during prenatal visits.	X	X				X	Although 88.9% of practitioners always or almost always advised women to stop smoking, 75% believed it was acceptable for pregnant women to smoke up to 6 cigarettes per day. The risk of SHS exposure was 'always or almost always discussed' by only 34.5% of physicians. Multivariate logistic regression showed that lack of training was associated with less counselling about smoking cessation (OR 0.18; 95% CI 0.04-0.82) and SHS exposure (OR 0.27; 95% CI 0.12-0.59). Current compared to never smokers had lower odds of smoking cessation counselling (OR 0.39; 95% CI 0.05-0.82). Current smokers were less likely than former smokers to counsel about SHS (OR 0.25; 95% CI 0.11-0.62).
Moran (2003) USA	Health Providers (Family Practitioner,	Low risk	To assess how frequently physicians identified the smoking status of pregnant				X			Physicians identified pregnant women's smoking status at 81% of visits but provided smoking counselling at only 23% of visits by pregnant smokers. Physicians were less

	General Practitioner, Obstetrician, & Gynaecologist)		patients and how frequently physicians counselled pregnant smokers.						likely to identify smoking status of non-White pregnant women but no less likely to counsel non-White smokers.
Mullen (1998) USA	Health Providers (Obstetricians)	Low risk	To describe Texas obstetricians' pregnancy smoking cessation counselling activity and to identify attributes associated with consistent, effective counselling.	X			X	X	X	Obstetricians who are not reached by expert reports and guidelines from groups outside their specialty or who do not perceive the seriousness of maternal smoking are less likely to counsel consistently and to use the most effective techniques.
Murphy (2016) South Africa	Health Providers (Midwifes)	Low risk	to assess the knowledge, attitudes, beliefs and current practices of South Africa midwives in relation to providing smoking cessation education or counselling to pregnant women.	X	X					This study identified several constraints to midwives fulfilling this role, which affected their perceived behavioural control. These included stressful working conditions, too little time, a dearth of educational resources and a lack of knowledge of best practice intervention methods and counselling skills. Perceived patient resistance to quitting was a further obstacle.
Oncken (2000) USA	Health Providers (Obstetrics & Paediatric)	Low risk	To assess smoking cessation counselling and nicotine replacement therapy prescription and recommendation practices among obstetric and paediatric providers.		X				X	We found that nicotine replacement therapies are commonly prescribed or recommended to pregnant smokers by obstetric providers, but less commonly to lactating women by paediatric providers.
Owen (1999) UK	Pregnant Women	Low risk	Examines pregnant women's reports of quality and quantity of health professional interventions from 1992 – 1999.		X					Less than 50% of pregnant smokers reported having received advice on smoking from a health professional during their current pregnancy: little change since the question was first asked in 1994. Advice, when given, appeared to have had little impact on smoking cessation, and did not follow best available evidence, namely to quit rather than cut down.
Passey (2012) Australia	Health Providers (AHW, Midwives or Nurses, Doctors)	High Risk-women Aboriginal and Torres Strait Islander	Aims to explore the knowledge and attitudes of health care providers caring for pregnant Australian Aboriginal women regarding smoking risk and cessation and identify factors associate with self-reported assessment of smoking. Optimal and assessment of smoking status.	X					X	Most respondents considered assessment of smoking status to be integral to antenatal care and a professional responsibility. Most (79%) indicated that they assess smoking status in 100% of clients. Knowledge of risks was generally good, but knowledge of cessation was poor. Factors independently associated with assessing smoking status among all women were: employer service type ($p = 0.025$); cessation knowledge score ($p = 0.011$); and disagreeing with the statement that giving advice is not worth it given the low level of success ($p = 0.011$).

Passey (2015) Australia	Pregnant Women	High Risk-women Aboriginal and Torres Strait Islander	Provision of antenatal smoking cessation support: A survey with pregnant Aboriginal and Torres Strait Islander women.	X	X		X			Despite most pregnant women who smoke reporting advice and support to quit, the persisting high prevalence of smoking suggests that this support is insufficient to overcome the many factors pushing women to smoke.
Passey (2014) Australia	Health Providers (AHW, Midwives or Nurses, Doctors)	High Risk-women High risk: Aboriginal and Torres Strait Islander	Supporting pregnant Aboriginal and Torres Strait Islander women to quit smoking: views of antenatal care providers and pregnant indigenous women.			NA*				Current smokers (n = 121) were less positive about the potential effectiveness of most of the 12 strategies than the providers (n = 127). For example, family support was considered helpful by 64 % of smokers and 91 % of providers; between 56 and 62 % of smokers considered advice and support from midwives, doctors or Aboriginal Health Workers likely to be helpful, compared to 85-90 % of providers. Rewards for quitting were considered helpful by 63 % of smokers and 56 % of providers, with smokers rating them more highly and providers rating them lower, than most other strategies. Quitline was least popular for both.
Price (2006) USA	Health Providers (Nurse-Midwives)	Low risk	Perceptions and Use of Smoking Cessation in Nurse-Midwives' Practice.	X	X	X	X	X	X	Few nurse-midwives identified barriers to counselling pregnant patients who smoked, but the most common were lack of time (14%) and not knowing where to send pregnant smokers for treatment (14%). Most respondents believed that nicotine replacement therapy (NRT) would be most likely to reduce the number of pregnant smokers (74%), yet few (26%) were confident in their ability to prescribe/recommend nicotine replacement therapy. Respondents more likely to use 5 A's can be characterized as the following: had higher efficacy expectations in their ability to communicate issues about the 5 A's and had higher outcome expectations regarding the effects of using the 5 A's.
Price (2006) USA	Health Providers (Obstetricians, Gynaecologists)	Low risk	Obstetricians and gynaecologists' perceptions and use of nicotine replacement therapy.	X	X	X	X	X	X	The majority did not prescribe NRT possibly because few respondents received cigarette smoking cessation training in medical school or their residencies. Significant revisions in professional training and more continuing medical education are needed regarding smoking cessation and use of NRT.
Pullon (2004) NZ	Health Providers (GPs Practicing Obstetrics, Midwives)	Low risk	Smoking cessation and nicotine replacement therapy in current primary maternity care.	X	X				X	Only about half of the health professional gave smoking cessation advice to most pregnant women who smoked. They were uncertain about the safety of NRT use in pregnant and breastfeeding women. Most respondents requested more information about NRT use.
Roske (2009) Germany	Health Providers (Midwives, Gynaecologists, Paediatrician)	Low risk	Smoking cessation counselling for pregnant and postpartum women among midwives, gynaecologists and paediatricians in Germany.	X	X		X			Depending on profession, 90 % to 100 % see smoking cessation counselling as their assignment, 17 % to 80 % screen for, 48 % to 90 % document smoking status, and 55 % to 76 % offer brief or extensive counselling. 61 % to 87 % consider training to enhance their knowledge and/or counselling skills necessary. The compliance of providers with the necessity to give support in smoking cessation is very high. However, the status of cessation counselling does not sufficiently correspond to the evidence based requirements.
Solberg (2010) USA	Pregnant Women	Low risk	Disparities in tobacco cessation medication orders and fills among special populations.				X		X	32,733 current users of tobacco, 18,047 of whom had both health insurance and pharmacy claims data available. After adjustment, 15.4% overall had received an order for cessation medications during this year, but only 78% had filled it. Groups receiving fewer orders than their comparison groups were aged 18-34 years or older than 65 years, men, pregnant women, Asians and Hispanics, and those with non-English-language preference, on Medicaid, or with fewer visits. The same groups were less likely to fill that prescription, except patients with non-English preference or Medicaid. There are disparities in both the receipt of cessation medication orders and the likelihood of filling them for some special

									populations. The causes are likely to be complex, but this information provides a starting point for learning to improve this problem.
Tappin (2010) UK	NA	Low risk	To establish a denominator for pregnant smokers in Scotland and describe the proportion who are referred to specialist services, engage in one-to-one counselling, set a quit date and quit 4 weeks later.	X			X		Poor smoking cessation outcomes are a product of current limitations to identification, referral, engagement and treatment. Carbon monoxide breath testing can bypass this difficulty of patient providing faulty information.
Thyrian (2006) Germany	Health Providers (Midwives)	Low risk	To establish a denominator for pregnant smokers in Scotland and describe the proportion who are referred to specialist services, engage in one-to-one counselling, set a quit date and quit 4 weeks later.	X	X		X		Smoking and exposure to environmental tobacco smoke are seen as prominent health threats that midwives reported they addressed routinely, including giving advice to stop smoking.
Tong (2008) USA	Pregnant Women	Low risk	Investigate the attitudes of midwives to counselling women about their smoking behaviour during pregnancy and post-partum.					X	Almost all women reported that their prenatal care provider asked if they smoked, but only 56.7% reported that a provider counselled them to quit smoking. Only 11.5% of women who smoked in late pregnancy used a cessation method, including self-help materials (6.3%); medications (3.9%); face-to-face counselling (1.7%); telephone-based counselling (1.5%); Internet-based counselling (1.3%); and a class or program (1.0%).
Tran (2010) USA	Pregnant Women	Low risk	To explore racial/ethnic disparities in the receipt of optimal smoking cessation counselling during prenatal care.	X	X		X		Of 594 first trimester pregnant smokers, the majority were asked and advised about smoking by a prenatal care provider. However, a substantial proportion of women did not receive assistance to quit and only 42.2% received all three steps. Significant racial/ethnic variations were found only in the Assist step. Compared to non-Hispanic (NH) White women, NH American Indian women had lower odds of receiving all three steps. In contrast, NH Black women had increased odds of receiving all three steps. We conclude that there is a need for prenatal care providers to address tobacco use, especially to Assist quitting, with all pregnant smokers.
Tzelepis (2017) Australia	Health Providers (AHW or Aboriginal Health Education Officers, Child Health Nurses, & Midwives)	High Risk-women Aboriginal	To examine Aboriginal antenatal and postnatal staff confidence, perceived role and delivery of smoking cessation care to Aboriginal women and characteristics associated with provision of such care.	X			X	X	X	Most staff reported they assessed clients' smoking status most or all of the time (92.2%). However, only a minority reported they offered a Quitline referral (42.2%), provided follow-up support (28.6%) or provided nicotine replacement therapy (4.7%) to most or all clients who smoked. Few staff felt confident in motivating clients to quit smoking (19.7%) and advising clients about using nicotine replacement therapy (15.6%). Staff confident with talking to clients about how smoking affected their health had significantly higher odds of offering a Quitline referral and quitting assistance to clients who smoke.
Walsh (1995) Australia	Health Providers (Medical Directors & Nursing Directors)	Low risk	To assess the smoking cessation practices of Australian public antenatal clinics.		X		X	X		Smoking advice was rated an essential activity at the first antenatal visit by 69% of responding directors. Nonetheless, only 12% of clinics indicated they offered relevant training and 4% reported written policies. Results also indicate senior staff may have suboptimal levels of awareness of smoking risks. Clinics used a narrow array of strategies

										to promote cessation. Almost one-third of directors said they advised smokers to cut down rather than stop smoking completely.
Zapka (2000) USA	Health Providers (Physician, Nurse-Practitioner or Midwife, RN, Nutritionists, Nutrition Assistant)	Low risk	Assess providers' performance of smoking cessation counselling steps with low-income pregnant and postpartum women receiving care at community health centres.	X	X	X	X	X	X	Providers in obstetric clinics had the highest scores and those in paediatric clinics had the lowest scores. Nurse practitioners and nutritionists had higher scores than other providers. Clinic type, greater smoking-related knowledge, older age, and perception of smoking cessation as a priority were independently related to better counselling performance. Low scores for performance of steps beyond assessment and advice indicate a need for emphasis on the assistance and follow-up steps of national guidelines. Providers' own commitment to helping mothers stop smoking was important.

NA – Not applicable to study or not described

Supplementary Text 1: Grouping of outcome measures for the meta-analyses

For each outcome (Ask, Advice, Assess motivation to quit, Assess nicotine dependence, Assist, Arrange follow up, Arrange referral, NRT), we looked at the specific measurement that was done to decide whether it was feasible to group together. To achieve this we looked both at data collection method – cross-sectional survey/ audit of patients medical records/ audio-recording of consultation/ women's report through survey or interview; and also on the measure itself that was used – Likert scale/ dichotomous YES/NO question and so forth.

ASK – overall 38 manuscripts had data on ASK. Out of these 12 used a survey measure reflecting asking all of their patients. We included in this analysis the proportion answering always if a Likert scale was used, or the proportion answering Yes if a dichotomous question was used either asking if you ask all of your patients? Or if you ask your patients always? Answers reflecting asking more than 75% of their patients were also considered as Yes for this analysis. 9 other manuscript used a survey measure reflecting asking usually and always – this including the combined answers in Likert scales (always and usually; and/or most of the time and all of the time). Two manuscripts provided data for both these measures (Bar-Zeev et al and Mejia et al). 4 other manuscripts used women's report whether they recall been asked during their pregnancy.

Advice – The same principles as used in ASK (see above). Advice always included 6 manuscripts using either Likert scales or asking whether you always advise your patients to quit. Advice always and often included 9 manuscripts using either a scale of always and often; or always and usually; or advising all and most of women; or a Yes/No question whether you advice routinely (to more than 50% of patients). Since 8 manuscripts used a more general "Do you advise Yes/No" question, without referring to the amount of patients this is done with, these were grouped separately as Advice Yes/No. 4 other manuscripts used women's report whether they recall been advised to quit during their pregnancy.

Assess motivation to quit – 10 manuscripts in total included some aspect of assessing motivation to quit. 1 used audio-recordings. 2 manuscripts used a measure calculating the mean on a different scale (1-5 and 1-3). 1 used women report. 1 reported on % always only. 1 reported on % usually always. 3 manuscripts assessed willingness to quit in general (with no time point included in the question) and reported on the proportion that answered "always and usually " – these were included in the meta-analysis. One paper asked a similar question but defined this as "% always usually assess whether the patient is willing to make a quit attempt within the next 30 days". Since this included a specific time-point it was considered to be different to the other 3 and not included.

Assess nicotine dependence – Only 3 papers included a question on this topic. 1 reported on % always and often; 1 reported on % always; and 1 reported also on % always and often but asked a general question on # of cig. smoked and not specific to assessing nicotine dependence. It was decided not to run a meta-analysis on these as too different.

Assist – This included many different definitions of assist in quitting – some were general about assisting the patient to quit, and some included a more specific method of assisting such as counselling or setting a quit data.

Overall 34 different manuscripts included some kind of question on assisting. 4 manuscripts had data on women's report on whether they recalled been offered any support to quit – these were general such as "Did your doctor or other HCP ever tell you (at least in one visit) about things you could do to quit smoking?", recalled being offered assistance to quit by health providers; report that their provider offered suggestions for quitting, recall health providers offer support to quit smoking yes/no. 3 manuscripts reported on % reporting always and often helping their patients to set a specific quit data – this included a Likert scale of always and often, or arrange setting a quit data with at least 50% of their patients, or arranging this with most and all of their patients. Only 1 extra manuscript reported specifically on a quit date but included a general not specific Yes/No question - % reporting they negotiate a quit date with their patients – therefore this was not included in the meta-analysis. For "Assist-Often-Always-CessationSupport" the same principles as for ASK were applied here as well – 'always and often' was combined with 'always and usually', and with 'most and all of the patients' and with 'to at least 50% of the patients'. Included in this were any questions using this measurement of general counselling or providing support or assistance – total 5 papers. An additional 5 papers were used for the meta-analysis for Assist-Yes-Counselling – this included any general questions about counselling Yes/No, any general statement of proportion reporting counselling. For Roske note that in the paper they separated based on those reporting providing counselling over 10 minutes and those reported providing brief counselling (under 10 minutes) – the total proportion providing counselling Yes/No was calculated combining these two together. Assist always often quit plan – only 2 papers included a measure about a quit plan and/or specific steps needed

to take to quit. Other papers included either other measures for these outcomes (for example a mean), or measured other assist such as assist by providing social support. These were different from each other so were not included in the meta-analysis.

Arrange follow up – Measures were different from each other so no meta-analysis was done. 2 manuscripts included a measure of always/often general follow up with no mention of a time point; 1 reported % following up on all of the patients; 1 measured % always following up but within a week; and 2 reported always/often within a week.

Arrange referral – Similar to the principles used for ASK (see above) – 6 papers measured % always/often referring - always and usually, always and often, all and most of patients. 3 papers measured always – we decided not to do a meta-analysis due to limits of # of meta-analysis, and these were only 3.

NRT – Same principles as for ASK regarding proportion reporting often/always prescribing NRT (4 papers) and proportion reporting always prescribing (4 papers). We also performed a meta-analysis on 6 papers that included a more general measurement of whether they prescribe or not – included in this were proportion reporting prescribing at least sometimes; proportion recalling prescribing NRT in pregnancy; proportion reporting using this method, proportion using this method currently.

Supplementary Forest Plot Figures 1-17

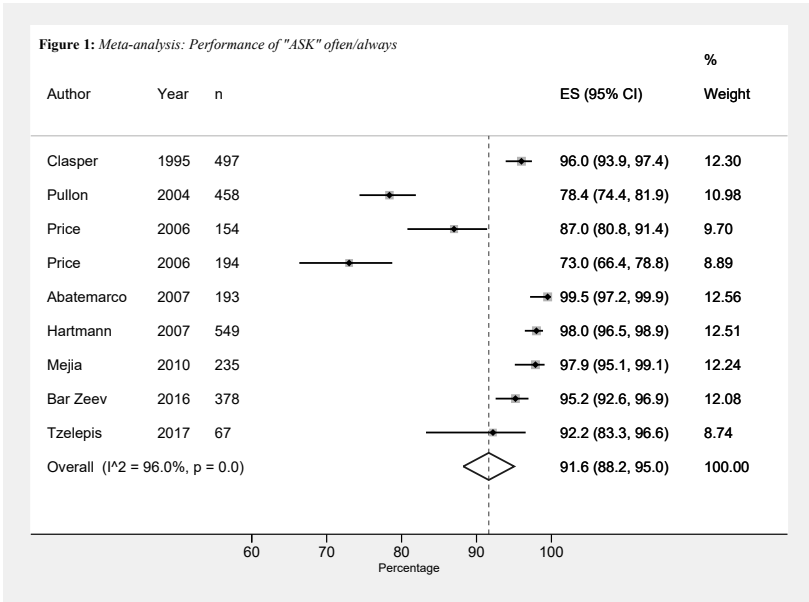


Figure 1: Meta-analysis: Performance of "ASK" often/always
Author
Year
n
ES (95% CI)
%
Weight
Clasper 1995 497 96.0 (93.9, 97.4) 12.30
Pullon 2004 458 78.4 (74.4, 81.9) 10.98
Price 2006 154 87.0 (80.8, 91.4) 9.70
Price 2006 194 73.0 (66.4, 78.8) 8.89
Abatemarco 2007 193 99.5 (97.2, 99.9) 12.56
Hartmann 2007 549 98.0 (96.5, 98.9) 12.51
Mejia 2010 235 97.9 (95.1, 99.1) 12.24
Bar Zeev 2016 378 95.2 (92.6, 96.9) 12.08
Tzelepis 2017 67 92.2 (83.3, 96.6) 8.74
Overall (I^2 = 96.0%, p = 0.0) 91.6 (88.2, 95.0) 100.00
60
70
80
90
100
Percentage

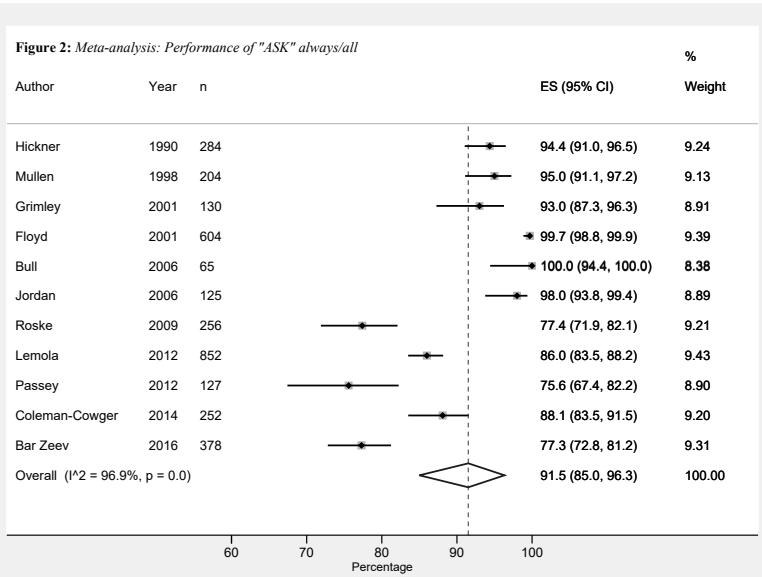


Figure 2: Meta-analysis: Performance of "ASK" always/all
Author
Year
n
ES (95% CI)
%
Weight
Hickner 1990 284 94.4 (91.0, 96.5) 9.24
Mullen 1998 204 95.0 (91.1, 97.2) 9.13
Grimley 2001 130 93.0 (87.3, 96.3) 8.91
Floyd 2001 604 99.7 (98.8, 99.9) 9.39
Bull 2006 65 100.0 (94.4, 100.0) 8.38
Jordan 2006 125 98.0 (93.8, 99.4) 8.89
Roske 2009 256 77.4 (71.9, 82.1) 9.21
Lemola 2012 852 86.0 (83.5, 88.2) 9.43
Passey 2012 127 75.6 (67.4, 82.2) 8.90
Coleman-Cowger 2014 252 88.1 (83.5, 91.5) 9.20
Bar Zeev 2016 378 77.3 (72.8, 81.2) 9.31
Overall (I^2 = 96.9%, p = 0.0) 91.5 (85.0, 96.3) 100.00
60
70
80
90
100
Percentage

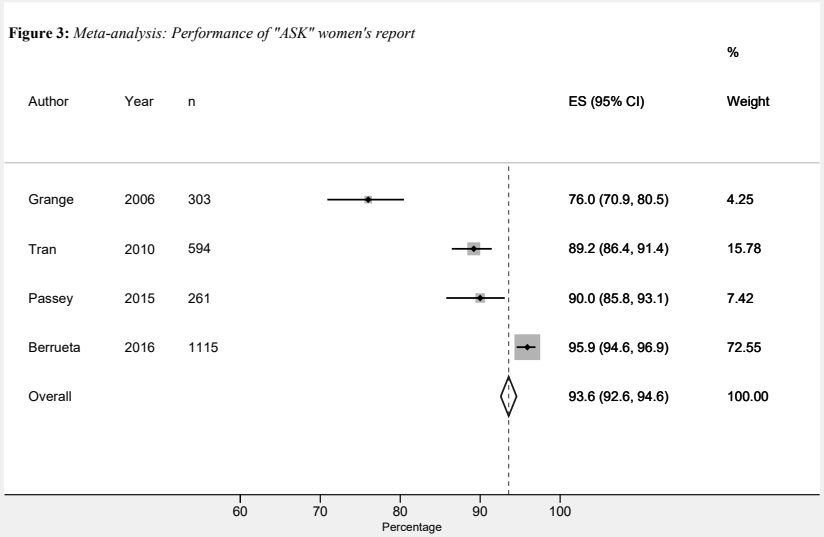


Figure 3: Meta-analysis: Performance of "ASK" women's report
Author
Year
n
ES (95% CI)
%
Weight
Grange 2006 303 76.0 (70.9, 80.5) 4.25
Tran 2010 594 89.2 (86.4, 91.4) 15.78
Passey 2015 261 90.0 (85.8, 93.1) 7.42
Berrueta 2016 1115 95.9 (94.6, 96.9) 72.55
Overall 93.6 (92.6, 94.6) 100.00
60
70
80
90
100
Percentage

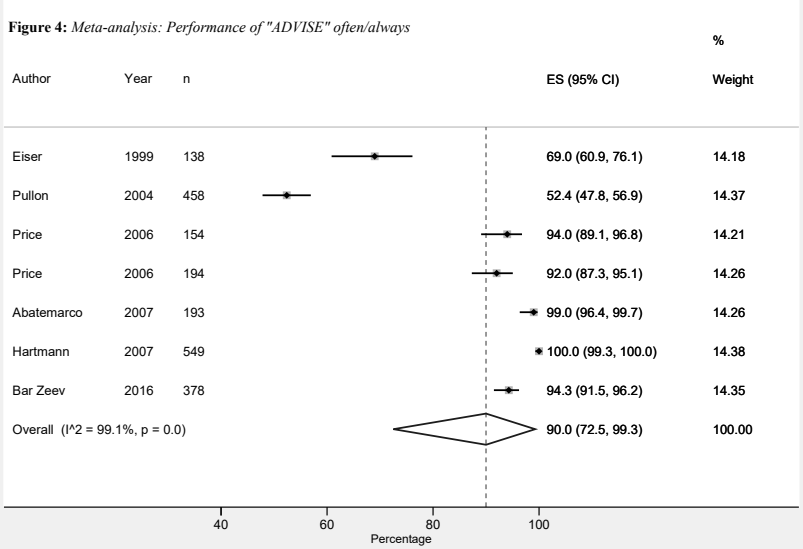


Figure 4: Meta-analysis: Performance of "ADVISE" often/always
Author
Year
n
ES (95% CI)
%
Weight
Eiser 1999 138 69.0 (60.9, 76.1) 14.18
Pullon 2004 458 52.4 (47.8, 56.9) 14.37
Price 2006 154 94.0 (89.1, 96.8) 14.21
Price 2006 194 92.0 (87.3, 95.1) 14.26
Abatemarco 2007 193 99.0 (96.4, 99.7) 14.26
Hartmann 2007 549 100.0 (99.3, 100.0) 14.38
Bar Zeev 2016 378 94.3 (91.5, 96.2) 14.35
Overall (I^2 = 99.1%, p = 0.0) 90.0 (72.5, 99.3) 100.00
40
60
80
100
Percentage

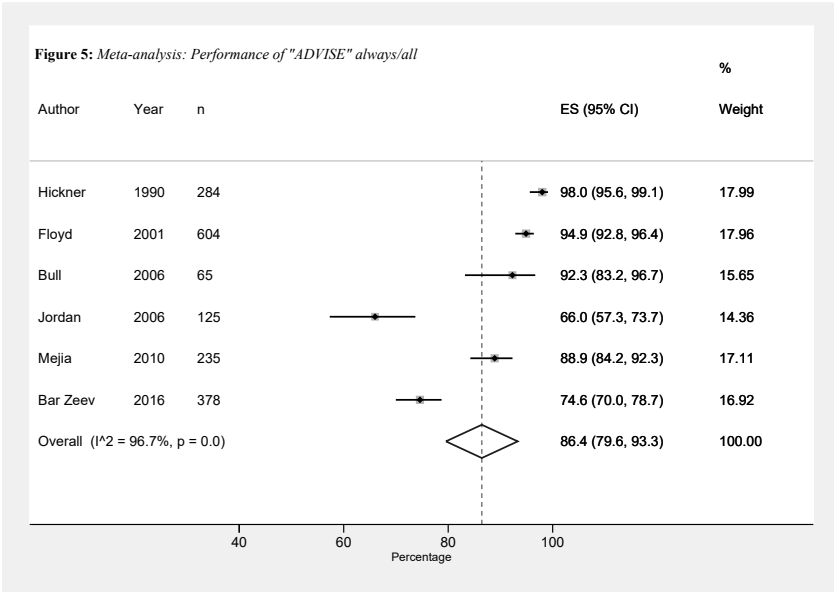


Figure 5: *Meta-analysis: Performance of "ADVISE" always/all*

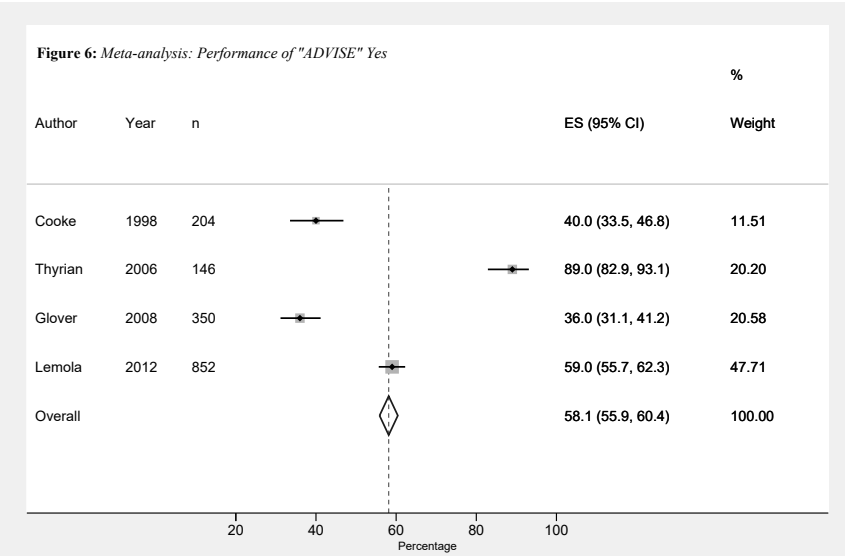


Figure 6: *Meta-analysis: Performance of "ADVISE" Yes*

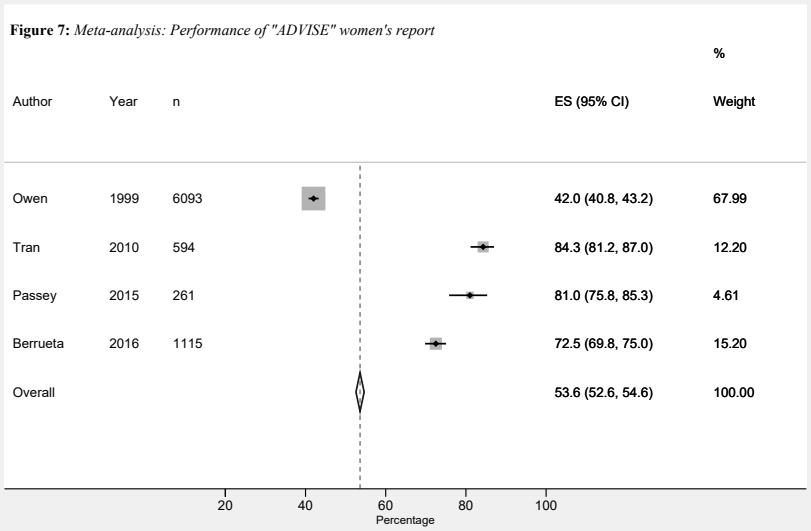


Figure 7: *Meta-analysis: Performance of "ADVISE" women's report*

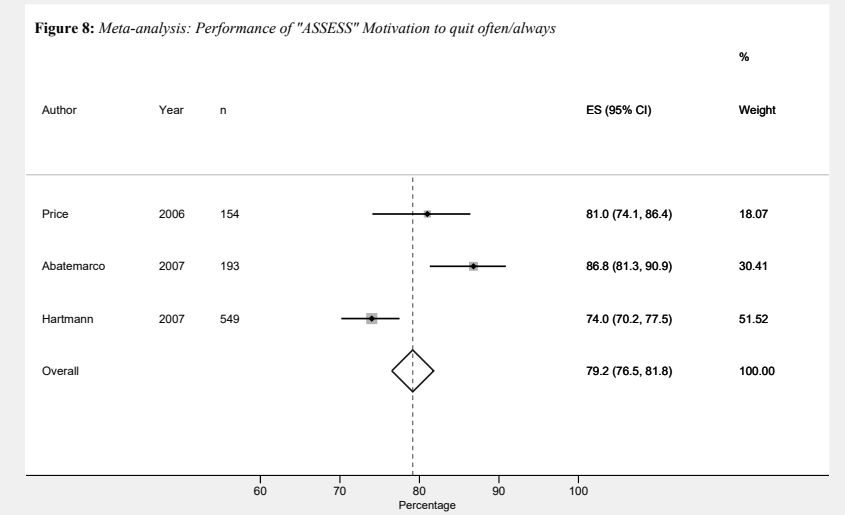


Figure 8: *Meta-analysis: Performance of "ASSESS" Motivation to quit often/always*

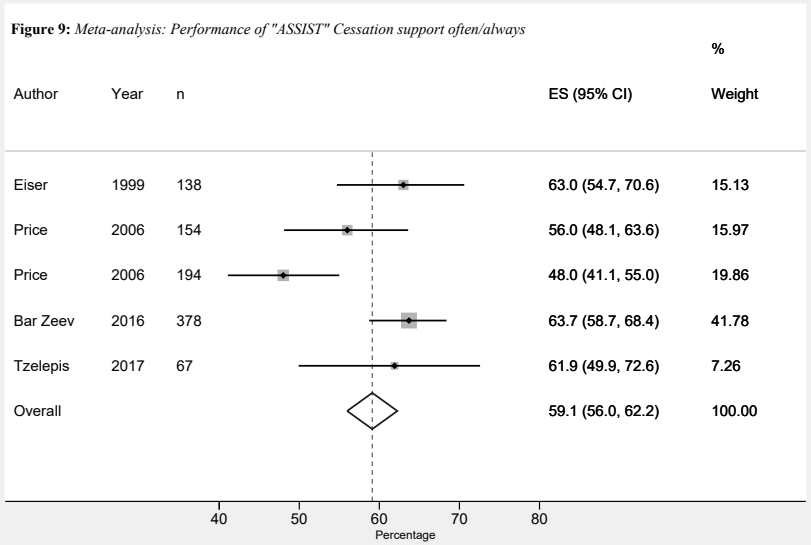


Figure 9: *Meta-analysis: Performance of "ASSIST" Cessation support often/always*

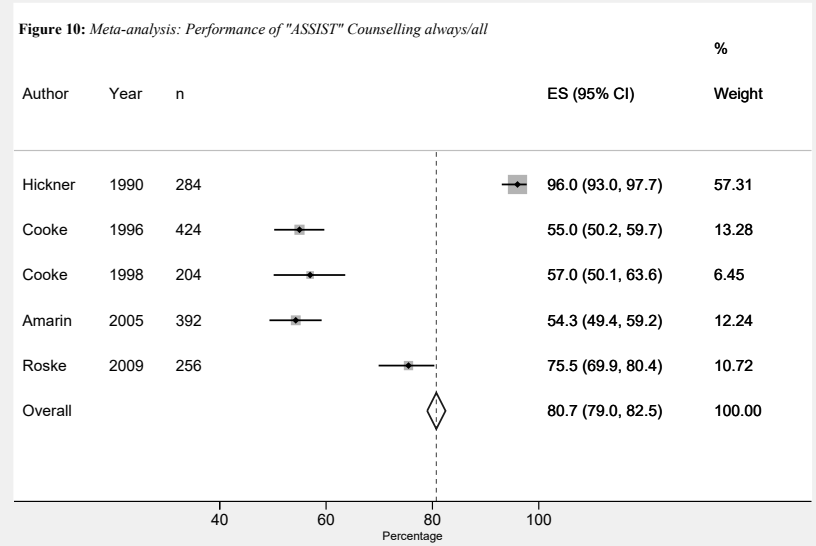


Figure 10: *Meta-analysis: Performance of "ASSIST" Counselling always/all*

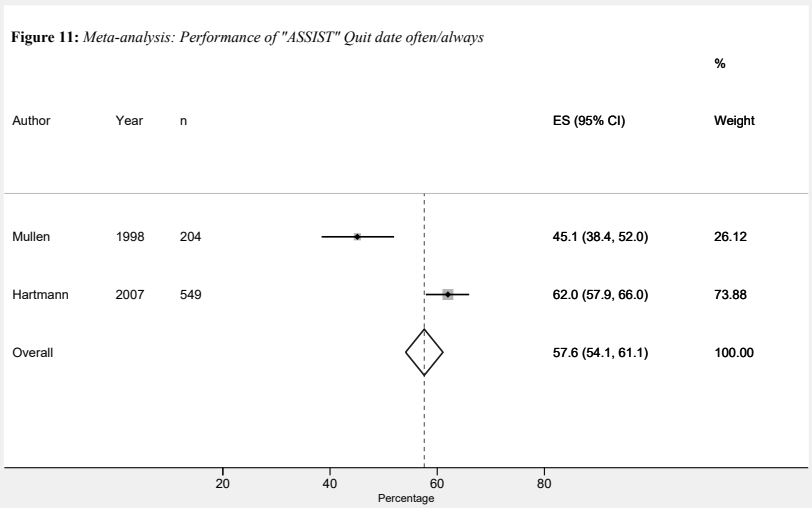


Figure 11: *Meta-analysis: Performance of "ASSIST" Quit date often/always*

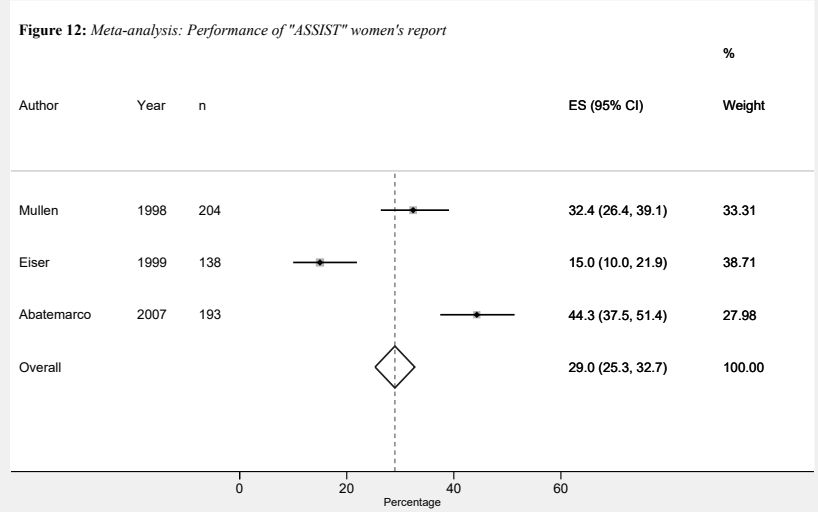


Figure 12: *Meta-analysis: Performance of "ASSIST" women's report*

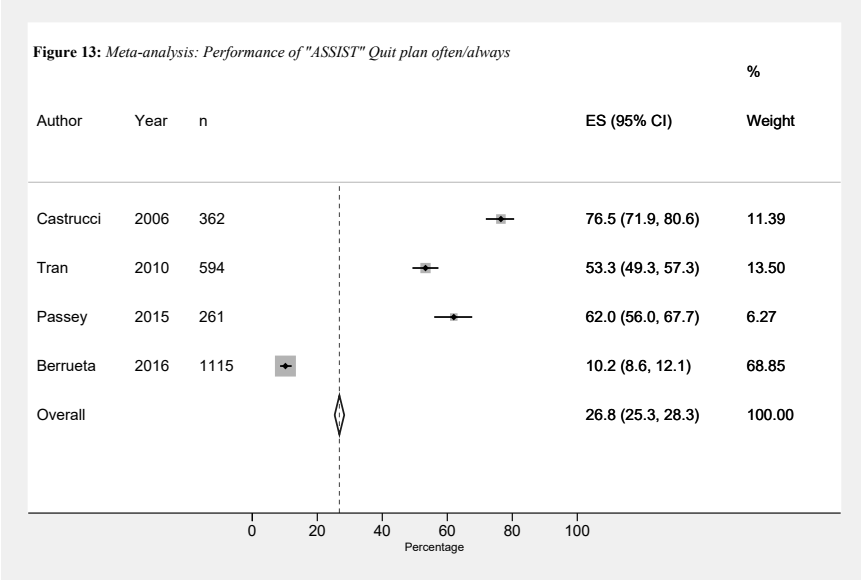


Figure 13: *Meta-analysis: Performance of "ASSIST" Quit plan often/always*

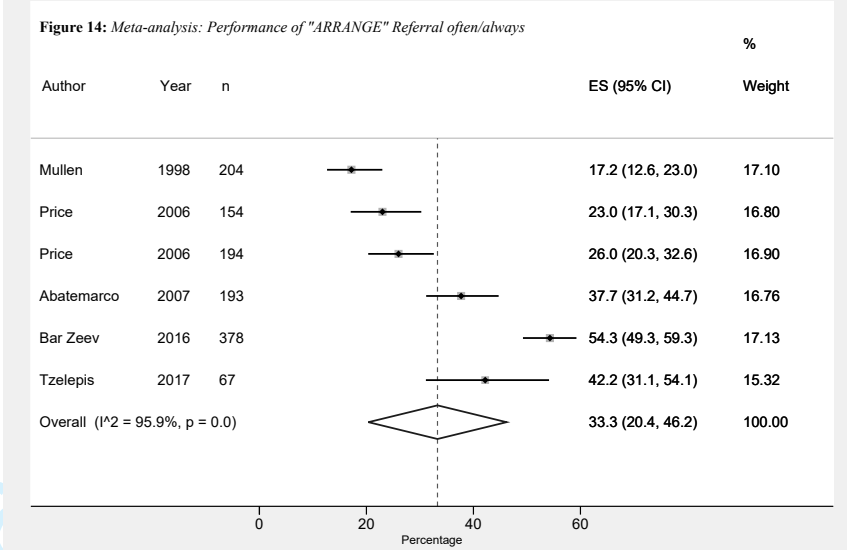


Figure 14: *Meta-analysis: Performance of "ARRANGE" Referral often/always*

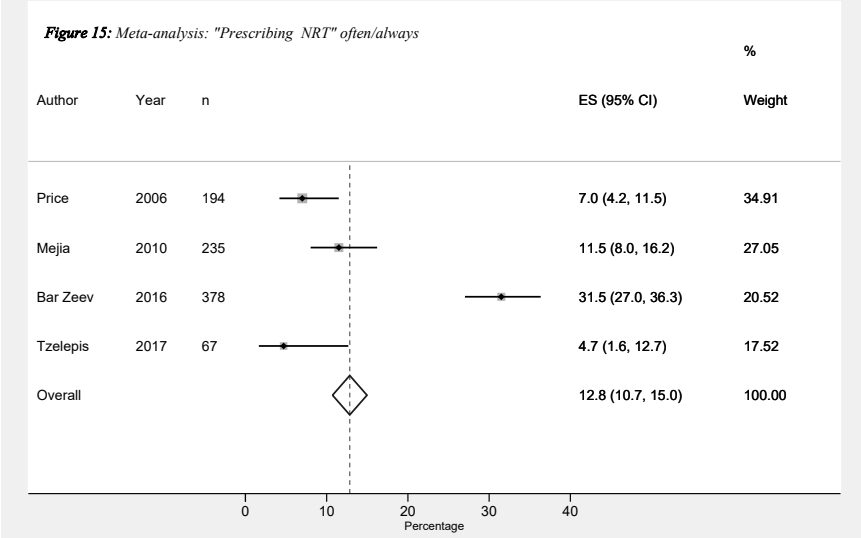


Figure 15: *Meta-analysis: "Prescribing NRT" often/always*

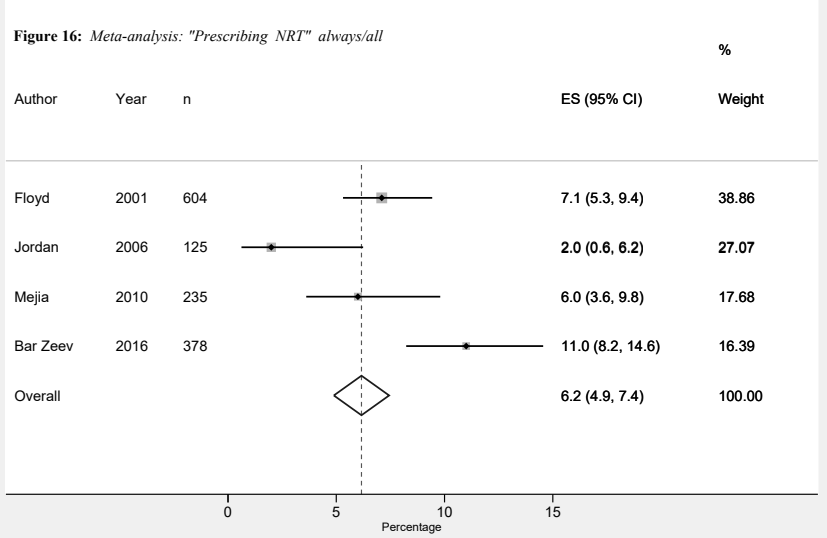
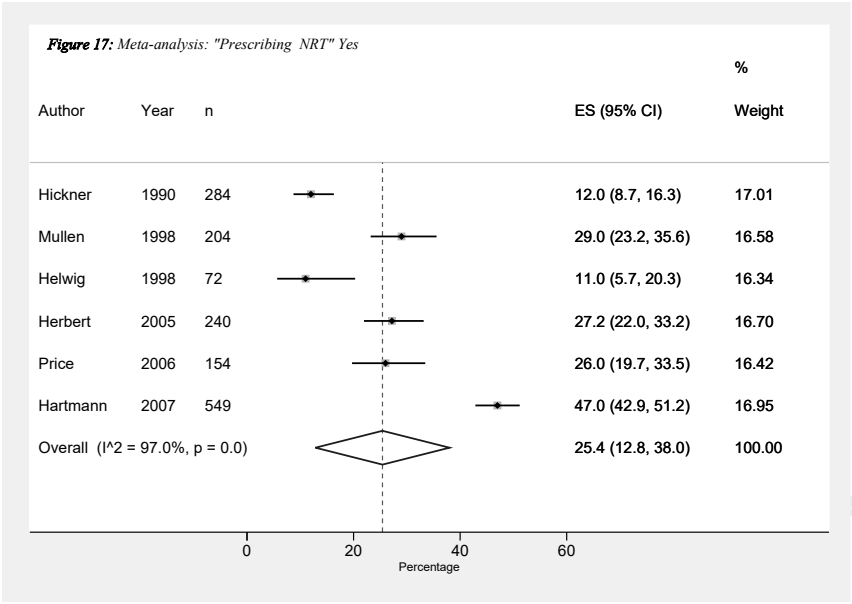


Figure 16: *Meta-analysis: "Prescribing NRT" always/all*



Reporting checklist for meta-analysis of observational studies.

Based on the MOOSE guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the MOOSE reporting guidelines, and cite them as:

Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, Moher D, Becker BJ, Sipe TA, Thacker SB. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. JAMA. 2000; 283(15):2008-2012.

	Reporting Item	Page Number
#1	Identify the study as a meta-analysis of observational research	NA
#2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number (From PRISMA checklist)	2-3
#3a	Problem definition	7
#3b	Hypothesis statement	NA
#3c	Description of study outcomes	11-16
#3d	Type of exposure or intervention used	NA
#3e	Type of study designs used	9, 11

	#3f	Study population	12
Search strategy	#4a	Qualifications of searchers (eg, librarians and investigators)	8
	#4b	Search strategy, including time period included in the synthesis and keywords	7
	#4c	Effort to include all available studies, including contact with authors	NA
	#4d	Databases and registries searched	7
	#4e	Search software used, name and version, including special features used (eg, explosion)	7
	#4f	Use of hand searching (eg, reference lists of obtained articles)	7-8
	#4g	List of citations located and those excluded, including justification	7-8
	#4h	Method of addressing articles published in languages other than English	NA
	#4i	Method of handling abstracts and unpublished studies	8
	#4j	Description of any contact with authors	NA
	#5a	Description of relevance or appropriateness of studies gathered for assessing the hypothesis to be tested	9-10
	#5b	Rationale for the selection and coding of data (eg, sound clinical principles or convenience)	8
	#5c	Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)	8-9
	#5d	Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)	NA
	#5e	Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results	9
	#5f	Assessment of heterogeneity	10
	#5g	Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated	10

#5h	Provision of appropriate tables and graphics	11
#6a	Graphic summarizing individual study estimates and overall estimate	NA
#6b	Table giving descriptive information for each study included	8
#6c	Results of sensitivity testing (eg, subgroup analysis)	10-11
#6d	Indication of statistical uncertainty of findings	11
#7a	Quantitative assessment of bias (eg. publication bias)	NA
#7b	Justification for exclusion (eg, exclusion of non–English-language citations)	NA
#7c	Assessment of quality of included studies	18
#8a	Consideration of alternative explanations for observed results	21
#8b	Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)	21
#8c	Guidelines for future research	21
#8d	Disclosure of funding source	22