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The Effectiveness of Smoking Cessation Interventions Tailored to Smoking Parents of Children Aged 0–18 Years: A Meta-Analysis

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Keywords
Smoking cessation · Parents · Second-hand smoking · Systematic review · Meta-analysis

Abstract
Introduction: A meta-analysis was conducted to examine the effectiveness of smoking cessation interventions tailored to parents of children aged 0–18 years. ***Methods:*** A systematic search was carried out in PsycInfo, Embase, and PubMed in March 2020. A manual search of the reference lists of the included studies and systematic reviews related to the topic was also performed. Two authors independently screened the studies based on the following inclusion criteria: (1) effect studies with control groups that examine smoking cessation interventions tailored to parents of children (0–18 years), and (2) full-text original articles written in English and published between January 1990 and February 2020. In total, 18 studies were included in the analyses. The TiDieR checklist and the Cochrane Risk of Bias Tool 2.0 were used to extract data and to assess the risk of bias. Consensus among authors was reached at each stage. ***Results:*** Random-effects meta-analyses were performed. With a total number of 8,560 parents, the pooled relative risk was 1.62 (95% CI 1.38–1.90; $p < 0.00001$), showing a modest effect of the interventions on smoking cessation. Overall, 13.1% of the parents in the intervention conditions reported abstinence versus 8.4% of the parents in the control conditions. ***Discussion/Conclusion:*** Smoking cessation interventions tailored to parents are modestly effective. To increase the effectiveness and the impact of these interventions in terms of controlling tobacco use and public health, it is crucial for further research to explore how these interventions can be improved.

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Introduction

Children's exposure to secondhand smoke (SHS) is a worldwide problem. Approximately half a billion children are exposed to SHS at home [1]. Parental smoking

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in the home is a major source of children's exposure to SHS and thirdhand smoke (THS) [2, 3]. Ample evidence has illustrated that exposure to SHS leads to serious health consequences for infants, children, and adolescents [4–6]. For example, children's exposure to SHS has been associated with sudden infant death syndrome, reduced lung function, and lower respiratory illnesses [4, 6]. In addition to SHS, children can also be exposed to THS. THS "consists of residual tobacco smoke pollutants that remain on surfaces and in dust after tobacco has been smoked, are re-emitted into the gas phase, or react with oxidants and other compounds in the environment to yield secondary pollutants" [3]. The presence of THS in the air, in dust, and on surfaces indicates that very young children are particularly vulnerable to THS due to crawling, hand-to-mouth and object-to-mouth behaviors, and playing near the floor [7]. To date, limited research has been published to identify the health consequences of exposure to THS in children [7, 8]. However, it is known that THS leads to exposure to toxic tobacco smoke pollutants [7, 8]. In addition to the health consequences of children's exposure to parental smoking, children of smoking parents are more likely to smoke in the future [9, 10]. This emphasizes the need to protect children from exposure to parental smoking.

Multiple interventions that primarily focus on reducing children's exposure to SHS in the home have been developed, examined, and shown to be effective (e.g., Harutyunyan et al. [11] and Hovell et al. [12]). However, the gains of interventions aimed at reduction to SHS exposure may be limited compared to interventions that aim at parental smoking cessation. First, since the focus of these interventions is reduction of children's exposure to SHS and not parental smoking cessation per se, these interventions are not likely to eliminate the detrimental health consequences of smoking to parents themselves. In addition, SHS reduction interventions are also not likely to completely eliminate children's exposure to THS. However, when parents quit smoking, children's exposure to SHS and THS is eliminated [2], the risk for children to start smoking diminishes [13], and the odds of morbidity and mortality for parents themselves decrease [14]. Third, interventions that primarily focus on parental smoking cessation, instead of on reduction of children's exposure to SHS and parental smoking cessation, have also been shown to be relatively more effective [15]. Fourth, research has shown that many parents want to quit smoking and even try to quit smoking [16]. In brief, based on this evidence, it is essential to examine interventions that exclusively aim at parental smoking cessation and not at reducing children's exposure to SHS. Parental smoking cessation may not be different from adult smoking cessation per se. However, the motivation to quit smoking could be different among parents than among other adult smokers (e.g., parents want to quit smoking because of their children's health [17, 18]).

To date, multiple interventions that mainly aim at parental smoking cessation have been examined. Several (systematic) reviews and meta-analyses have assessed parental smoking cessation rates of SHS reduction and cessation interventions [15, 19–21]. To our knowledge, only one meta-analysis (performed in 2012) examined interventions in which parental smoking cessation was the main objective [15]. However, this analysis was carried out as a subgroup analysis and included only five studies. Since 2012, several new studies (e.g., see Schuck et al. [22], Borrelli et al. [23], and Scheffers-van Schayck et al. [24]) have been published, which requires an update. In addition, this previous meta-analysis focused on interventions tailored to parents of young children (aged between 0 and 6 years), thereby limiting the contribution as the effects of parental smoking are not limited to early childhood and the level of children's exposure to parental smoking increases when children become older [25, 26]. To summarize, there is a gap in evidence on the effectiveness of interventions that mainly aim at parental smoking cessation. Because of this gap and the potential of these interventions to eliminate the detrimental health consequences of smoking and exposure to smoking, the aim of this meta-analysis was to examine effect studies testing interventions (e.g., telephone counseling) that mainly aim at helping parents (of children and adolescents aged 0–18 years) to quit smoking.

Methods

Search Strategy and Data Selection Process

This study was conducted in accordance with the PRISMA statement [27] and registered in the Prospero database of systematic reviews (registration No. CRD42018086797). In collaboration with the first author, a professional information expert in searches for systematic reviews performed a systematic literature search in PsycInfo, Embase, and PubMed in March 2020. The search terms that were used included a combination of terms for parents, cessation, program, and smoking. In addition, a manual search of the reference lists of the included studies, systematic reviews, and meta-analyses related to our topic was performed. To be included, the studies had to be: (1) effect studies (e.g., randomized controlled trials; RCTs) with control groups that examined smoking cessation interventions tailored to current parents (of children and adolescents 0–18 years old); (2) studies of which the primary outcome was smoking cessation (e.g., self-reported 7-day point prevalence abstinence; PPA) and not reduction in children's exposure to SHS

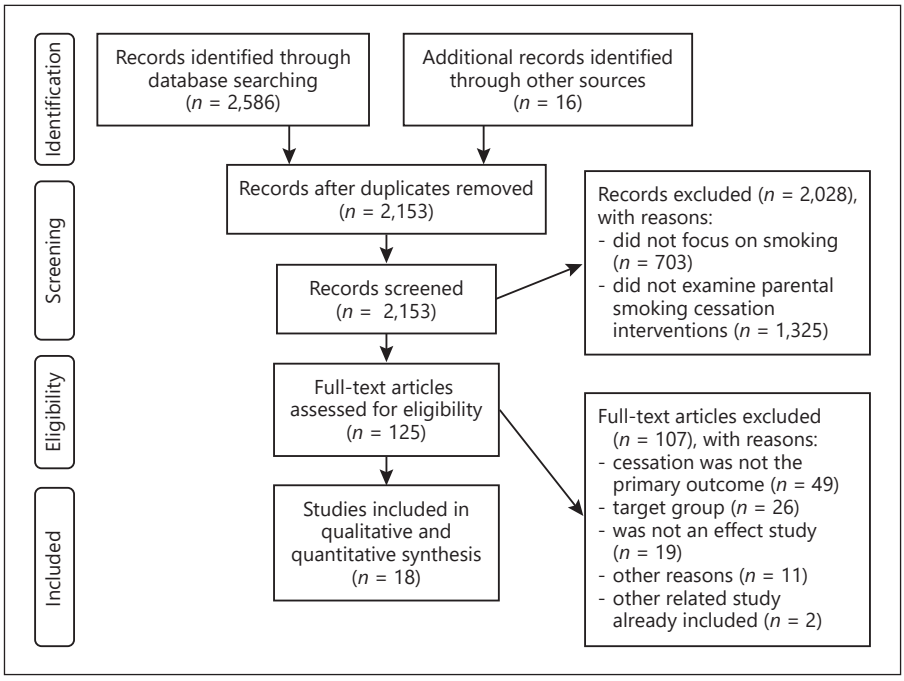

Fig. 1. PRISMA study flow diagram.

or relapse prevention, and (3) full-text original articles written in English and published between January 1990 and February 2020. Studies that involved cessation interventions for pregnant women were excluded because pregnant women who smoke are a specific target group and more likely to have multiple and complex problems in addition to their nicotine addiction (e.g., family and financial problems) [28]. Studies that aimed at both smoking cessation and relapse prevention/reduction in SHS exposure were only included if smoking cessation was the primary outcome. In cases where full-text articles were not available, attempts were made to obtain the full-text articles from the authors.

Figure 1 presents the PRISMA study flow diagram [27]. After excluding duplicates, the titles and abstracts of 2,153 studies were independently screened by 2 authors (T.S.-v.S. and A.M.) based on the inclusion criteria (agreement: 95.8%; Cohen's kappa = 0.55). If there were any doubts about the eligibility of studies, studies were included for full-text screening. At this stage, 2,028 studies were excluded. The full text of the remaining 125 potential eligible studies were independently read by the same 2 authors and checked for inclusion (agreement: 89.6%; Cohen's kappa = 0.72). Of these 125 studies, 107 were excluded due to various reasons (see Fig. 1). Overall, 18 studies were included in the subsequent analyses. Any disagreements between the two screening authors throughout the data selection process were resolved by discussion and, if necessary, by consulting a third author (R.O. or M.K.).

Data Extraction Process and Risk of Bias Assessment

One author (T.S.-v.S.) used the TiDieR checklist [29] to extract data from the 18 included articles. For four studies [30–33], four other articles were also used for the data extraction [34–37]. A second author (A.M.) and a research assistant checked whether the data extraction was done correctly (each checked approximately half of the articles). The following data were extracted concerning the study characteristics: authors, year of publication, methodological and sample characteristics (e.g., study design, country, age of parents, sample size), and primary outcomes and measurements (e.g., measurement method and biochemical validation; see Table 1). In addition, a variety of intervention characteristics were extracted (e.g., theories or theoretical principles, providers, activities, and materials; see Table 2). The following data were extracted for the overall statistical analysis: number of parents in the intervention and control conditions, and number of parents that reported abstinence in the intervention and control conditions. In addition, for the four subgroup analyses the following data were extracted: (1) theoretical basis of the intervention (yes/no); (2) provision of nicotine replacement therapy (NRT) during the intervention (yes/no); (3) risk of bias judgement (low risk of bias/some concerns about bias/high risk of bias), and (4) intervention that parents in the control condition received (passive/active). Interventions that were provided to the control condition (e.g., a self-help brochure) were categorized as "active" if the interventions focused on smoking cessation. In contrast, if the interventions did not focus on smoking cessation, they were categorized as "passive."

The risk of bias was assessed using the Cochrane Risk of Bias Tool 2.0 [38]. Two authors (T.S.-v.S. and A.M.) independently assessed the risk of bias at outcome level for the 17 studies on three levels (i.e., low risk of bias, some concerns about bias, and high risk of bias). Because the authors of one of the included studies [24] were for the greater part also involved in the present meta-analysis, the risk of bias assessment was conducted by 2 independent researchers. More specifically, the 18 studies were assessed on the following criteria: (1) randomization process (i.e., randomization and concealment); (2) blinding of participants, caretakers, and research staff; (3) missing outcome data; (4) measurement of the outcome, and (5) selection of the reported results. Disagreements between the authors in the process of data extraction and risk of

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Table 1. Study characteristics, methods, and results of the 18 included studies (alphabetically ordered)

First author [Ref], year; country	Study design	n[1]	Recruitment setting	Target group	Male gender, %	Age	Control condition	Primary outcome[2]	Biochemical validation primary outcome	Type of measurement primary outcome	Cessation rates (primary outcome)
Abdullah [30], 2005; China	2-arm RCT	903	Health care setting and another research project	Daily or occasional smoking parents of children aged 5 years	84.3	≤35 years: 34.7% 36–45 years: 54.6% ≥46 years: 10.7%	One stage-matched self-help materials	Self-reported 7-day PPA at 6-month FU	Yes	Telephone interview	Intervention: 15.3% Control: 7.4% OR 2.1 (95% CI 1.4–3.4)
Borrelli [43], 2010; USA	2-arm RCT	133	Health care setting, mass media, other research projects, other participants, and other sources	Daily smoking parents of children with asthma (<18 years)	27.1	M = 36.8 years SD = 9.6 years	There was no control condition in this study. This study had two intervention conditions	Self-reported 7-day PPA at 3-month FU	Yes	Questionnaire	PAM intervention: 22.0% BAM intervention: 18.4% OR 1.25 (95% CI 0.53–2.92)
Borrelli [23], 2016; USA	3-arm RCT	560	Health care setting and community	Daily smoking parents of children with asthma or healthy children (3–17 years)	17.9	M = 35.4 years SD = 1.0 year	There was no control condition in this study. This study had three conditions, but the interventions were only tested in two conditions	Self-reported 30-day PPA at 4-month FU	Yes	Questionnaire	For the purpose of this meta-analysis, only the cessation rates between the two intervention conditions are reported. PAM intervention: 18.2% Enhanced-PAM intervention: 9.9% OR 2.12 (95% CI 1.09–4.12)
Caldwell [33], 2018; USA	2-arm cluster RCT	453 (smoking parents: 110)[5]	School setting	Smoking and non-smoking parents of children in fourth grade	Intervention: 11 Control: 10	Intervention: M = 39.4 years SD = 16 years Control: M = 36.6 years SD = 9 years	Self-help materials on smoking cessation	Self-reported quit status at 48-month FU	Yes	Questionnaire	The results below concern parents who smoked at enrollment Intervention: 41% Control: 13% $p < 0.001$
Chan [45], 2005; China	2-arm pilot RCT	80	Health care setting	Daily smoking parents of sick children	73.8	25–34 years: 27.5% 35–44 years: 45.0% 45–58 years: 27.5%	Healthy diet counseling for parents' sick children	Self-reported 7-day PPA at 1-month FU	No	Telephone interview	Intervention: 7.5% Control: 2.5% $p = 0.62$
Chan [48], 2008; China	2-arm RCT	1,483	Health care setting	Non-smoking mothers who had a current smoking partner and a sick child	0	80.8% of the fathers were between 31 and 50 years	Usual care	Self-reported 7-day PPA at 12-month FU	No	Telephone interview	Intervention: 11.3% Control: 9.3% $p = 0.21$
Chan [44], 2017; China	2-arm RCT	1,158	Health care setting	Parents of infants (0–18 months) of whom the mothers did not smoke and the fathers smoked daily	50	Intervention: M = 31.3 years (mothers)/ M = 35.7 years (fathers) Control: M = 31.2 years (mothers)/ M = 35.4 years (fathers)	Self-help materials on smoking cessation and a brief advice	Self-reported 7-day PPA at 12-month FU	Yes	Telephone interview	Intervention: 13.7% Control: 8.0% OR 1.92 (95% CI 1.16–3.17)
Curry [46], 2003; USA	2-arm RCT	298	Health care setting	Smoking mothers	0	M = 34 years	No information	Self-reported 7-day PPA at 12-month FU	Yes	Telephone interview and in person survey	Intervention: 13.5% Control: 6.9% OR 2.77 (95% CI 1.24–6.60)
Groner [39], 2000; USA	3-arm RCT	479	Health care setting	Daily smoking mothers of children (<12 years)	0	16 years and older	Age-appropriate child safety information and corresponding hand-outs	Self-reported 7-day PPA at 6-month FU	No	Telephone interview and questionnaire	This study had two intervention conditions. Cessation rate of all mothers: 3.7%. There were no significant differences between the three conditions
Hannöver [31][3]; 2009; Germany	2-arm RCT	642	Health care setting	Mothers who had recently given birth and smoked regularly (or had smoked regularly before and/or during pregnancy)	0	M = 25.9 years SD = 5.5 years	Self-help materials on smoking cessation	Self-reported 4-week PPA at 24-month FU	No	Telephone interview and questionnaire	The results below concern mothers who smoked at enrollment (intervention: $n = 151$; control: $n = 187$). Intervention: 9% Control: 4% Difference in proportions: 4.3% (95% CI –0.9 to 10.3)

Table 1 (continued)

First author [Ref], year; country	Study design	n^1	Recruitment setting	Target group	Male gender, %	Age	Control condition	Primary outcome[2]	Biochemical validation primary outcome	Type of measurement primary outcome	Cessation rates (primary outcome)
Mahabee-Gittens [47], 2008; USA	2-arm pilot RCT	356	Health care setting	Current smoking parents/ legal guardians of children ≤18 years	21	M = 31.9 years SD = 9.2 years	Usual care, no specific information on smoking cessation	Repeated self-reported 7-day PPA at 6-week and 3-month FU	No	Telephone interview	Intervention: 4.2% Control: 1.7% OR 2.58 (95% CI 0.56–12.0)
Ralston [42], 2008; USA	2-arm RCT	42	Health care setting	Daily smoking parents of children who were hospitalized for respiratory illness	Intervention: 48 Control: 34	Intervention: Age ≥25 years: 76% Control: Age ≥25 years: 71%	A brief antismoking message and referral to the state's quitline	Self-reported quit status at 6-month FU	No	Telephone interview	Intervention: 14% (95% CI 3–36) Control: 5% (95% CI 0.1–24)
Ralston [49], 2013; USA	2-arm RCT	60	Health care setting	Daily smoking parents of children who were hospitalized	Intervention: 20 Control: 34	Intervention: M = 29.9 years Control: M = 28.3 years	Age-appropriate written patient education and safety recommendations	Self-reported ≥ 7-day PPA at 2-month FU	No	Telephone interview	Intervention: 17% (95% CI 7–34) Control: 20% (95% CI 9–38)
Scheffers-van Schayck [24], 2019; the Netherlands	2-arm RCT	83	Health care setting, school setting, and online mass media	Daily or weekly smoking parents of children 0–18 years	42.2	M = 39.2 years SD = 7.2 years	Self-help materials on smoking cessation	Self-reported 7-day PPA at 3-month FU	Yes	Questionnaire	Intervention: 53.3% Control: 13.2% OR 7.54 (95% CI 2.49 – 22.84)
Schuck [22], 2014; the Netherlands	2-arm RCT	512	School setting	Daily or weekly smoking parents of children 9–12 years	47.5	M = 42.2 years SD = 5.4 years	Self-help materials on smoking cessation	Self-reported 7-day PPA at 12-month FU	Yes	Questionnaire	Intervention: 34.0% Control: 18.0% OR 7.54 (95% CI 1.76–4.49)
Severson [32][4]; 1997; USA	2-arm cluster RCT	2,901	Health care setting	Mothers (current smokers or recent quitters) of newborns	0	Intervention: M = 25.7 years SD = 5.8 years Control: M = 25 years SD = 5.6 years	Self-help materials on the consequences of SHS	Repeated self-reported 7-day PPA at 6- and 12-month FU	No	Questionnaire	The results below concern mothers who smoked at enrollment (intervention: n = 1,073; control: n = 802). Intervention: 2.3% Control: 1.2% $\chi^2 = 2.94$ $p < 0.05$
Winickoff [50], 2010; USA	2-arm RCT	101	Health care setting	Parents (current smokers or recent quitters) of newborns	Intervention: 33 Control: 34	Intervention: median age: 28 years Control: median age: 30 years	Usual care	Self-reported 7-day PPA at 3-month FU	Yes	Telephone interview	The results below concern parents who smoked at enrollment (intervention condition: n = 33, control condition: n = 33) Intervention: 15% Control: 9% $p > 0.05$
Yu [40], 2017; China	3-arm RCT	342[5]	Health care setting	Smoking fathers and non-smoking mothers of newborns	49.6	Fathers: M = 31.8 years SD = 4.5 years Mothers: M = 29.6 years SD = 3.8 years	Usual care with no information on SHS and smoking cessation	Self-reported quit status at 12-month FU	No	Questionnaire	This study had two intervention conditions Intervention 1: 16.7% Intervention 2: 22.7% Control: 9.7% Intervention 2 vs. intervention 1: OR 1.38 (95% CI 0.67–2.84) Intervention 2 vs. control condition: OR 2.93 (95% CI 1.24–6.94) Intervention 1 vs. control: OR 2.13 (95% CI 0.88–5.15)

FU, follow-up; M, mean; PPA, point-prevalence abstinence; OR, odds ratio; RCT, randomized controlled trial; SD, standard deviation; SHS, secondhand smoke.

[1] Number of parents who were included in the statistical analyses of the studies.

[2] Primary outcomes that were reported in the studies. In case it was unclear what the primary cessation outcomes were, 7-day PPA (or an outcome that most closely resembled 7-day PPA; e.g., 30-day PPA) was reported as the primary outcome. If cessation outcomes were measured at multiple time points, results assessed at the latest FU were reported as the primary outcome. The primary cessation outcomes that were reported in the studies were not always included in our meta-analyses (see Table 1 for the outcomes that were included in the meta-analysis).

[3] Hannöver et al. [31] and Thyrian et al. [34] examined the same intervention. Only the results of Hannöver et al. [31] were included in the meta-analysis because these cessation outcomes were assessed at a later FU. Additional information on the enrollment and intervention was found in Thyrian et al. [34].

[4] Severson et al. [32] and Wall et al. [35] examined the same intervention. Only the results of Severson et al. [32] were included in the meta-analysis because these cessation outcomes were assessed at a later FU. Additional information on the sample, enrollment, and intervention was found in Wall et al. [35].

[5] Complete case analyses (and no intention-to-treat analyses) were carried out in this study.

Table 2. Intervention characteristics of the 18 included studies (alphabetically ordered)

First author [Ref], year	Theoretical base or rationale	Mode of delivery	Sessions, *n* (duration)	Short description	NRT	Training providers	Tailoring	Fidelity
Abdullah [30], 2005	TMC and 5Rs	Telephone and self-help materials	3 telephone counseling sessions (20–30 min), hotline available if needed	Counselors adopted a non-directive approach (including enhancing parent's stage of readiness in quitting smoking) and addressed several topics on cessation	No	4-day training course on smoking cessation Counselors had to pass a final assessment in order to give the counseling	Tailored to the parent's needs, queries, and stage of change	10% of the calls were audio recorded and evaluated for accuracy and completeness, which was satisfactory
Borrelli [43], 2010	SCT, MI, clinical guidelines for smoking cessation, and Elicit-Provide-Elicit Process	Face-to-face, telephone, and self-help materials	3 home visits, 1 phone call (5–10 min)	This study had 2 intervention conditions: BAM and PAM BAM focused on increasing the parent's self-efficacy to quit smoking through teaching PAM focused on increasing risk perception by using graphical and verbal feedback on the parent's carbon monoxide level and the child's SHS exposure level. Parents were also motivated to quit smoking and strategies for quitting were discussed	Yes	Counselor was trained in MI and the protocol Skill acquisition was determined by observation of counseling behaviors	PAM was designed to be consistent with the values of the Latino culture	Weekly supervision between counselor and trainers A weekly review of patient exit interviews, counseling sessions, and documentation of intervention components delivered
Borrelli [23], 2016	MI	Face-to-face and telephone	2 home visits (1 h) and 6 telephone calls (15–20 min)	This study had 2 intervention conditions: PAM and enhanced PAM Both: two home visits on smoking cessation and asthma (e.g., by providing graphical and verbal feedback on parent's carbon monoxide level). Four months later, parents received 6 telephone calls on asthma symptoms and management Enhanced PAM: parents received smoking cessation counseling (e.g., including MI and building readiness/confidence for change) and a second round of exposure to SHS feedback (i.e., comparing the SHS value that was obtained during the home visits to the current SHS value)	Yes	Counselors were trained using role-plays and a written treatment protocol, for example Skill acquisition was determined by intervention delivery with pilot participants 20% of the sessions were weekly reviewed with counselors	No information	Best practice guidelines were followed Sessions were coded using the MITIC by three coders
Caldwell [33], 2018	MI	Face-to-face, telephone (optional), and self-help materials	8 sessions (10–15 min; telephone or at schools/local community setting)	In the sessions, multiple communication strategies were applied (e.g., reflective listening)	Yes	Counselors were trained in MI and had extensive experience with patient counseling Counselors used a scripted protocol to provide the sessions	Tailored to parents and their individual needs and readiness to change Matched sex/racial/ethnically counselor	No information
Chan [45], 2005	Standardized six-step approach for motivating health behavior change	Face-to-face and telephone	1 face-to-face session (30 min) at the HCC and 1 phone call after a week	The session included: 1. An assessment of parent's stage of readiness 2. The standardized six-step approach for motivating health behavior change 3. An appropriate stage-matched intervention to increase motivation and decrease resistance to quit The aim of the phone call was to check on parents' progress in smoking cessation	No	The provider was a trained nurse counselor	Stage-matched intervention on smoking cessation	No information
Chan [48], 2008	TPB	Face-to-face, self-help materials, and telephone	1 face-to-face session and 1 phone call after a week	The intervention was provided to non-smoking mothers whose partners smoked and included: 1. Education on the health risks of passive smoking exposure for sick children. Mothers were motivated to advise their partners to quit smoking 2. A routine procedure, including: a 5-min standardized health advice on SHS, self-help materials for mothers and partners, and a 1-week telephone follow-up	No	The providers were nurses	No information	No information
Chan [44], 2017	TMC, SCT, and SET	Face-to-face, telephone, and self-help materials	Both: family counselling session (optional) Mothers: 1 face-to-face session at the HCC and 2 telephone sessions (30 min) Fathers: 3 telephone sessions (30 min)	The intervention was provided to daily smoking fathers and non-smoking mothers. The self-help materials and counseling sessions focused on smoking cessation. The optional family counseling session had several aims, including establishing mutual support between parents	Yes	Nurse counselors with extensive training and experience in smoking cessation	No information	No information

Table 2 (continued)

First author [Ref], year	Theoretical base or rationale	Mode of delivery	Sessions, *n* (duration)	Short description	NRT	Training providers	Tailoring	Fidelity
Curry [46], 2003	MI and 3As	Face-to-face, self-help materials, and telephone	Brief message from clinician during visit at the HCC and 1 face-to-face session at the clinic and up to 3 phone calls from nurses/ study interventionists	Clinicians: 1. Provided a brief motivational message to inform mothers about smoking and SHS and the health consequences 2. Provided a self-help brochure on smoking cessation 3. Asked mothers to have an in-person motivational interview with a nurse for a few minutes after the child's visit Nurses/study interventionists: 1. Had an in-person motivational interview to motivate mothers to consider quitting smoking 2. Provided up to three telephone counseling calls that encouraged mothers to read the self-help brochure, boost their motivation to quit smoking, and provided technical assistance to quit smoking	No	70 clinicians received individual training (e.g., role-playings) The motivational interview and telephone counseling was delivered by nurses and study interventionists who received individual training (8 h) and an extensive intervention manual	Tailored to mothers by the 10 intervention goals that were based on mothers' readiness to quit smoking	Quarterly in-person lunch meetings Biweekly supervision by telephone Counselors needed to complete visit and telephone call summary sheets on the intervention components that were delivered. These sheets were reviewed
Groner [39], 2000	HBM	Face-to-face and self-help materials	1 face-to-face session at the HCC	This study had two intervention conditions: Child Health Group (CHG) and Maternal Health Group (MHG) Both interventions included self-help materials on smoking cessation CHG: counseling session on the hazards of SHS on children, but not on the mothers' health MHG: counseling session on the effects of smoking on their mothers' health, not on the children's health	No	A trained research nurse provided the counseling session	No information	No information
Hannöver [31], 2009	MI, relapse prevention, and TMC	Face-to-face, telephone, and self-help materials	1 face-to-face session at home (up to 45 min) and 2 telephone sessions (up to 45 min)	The counseling sessions included balancing of the pros and cons of smoking, the health consequences of smoking and exposure to SHS, self-efficacy for behavior change, exploring high-risk situations and relapse prevention strategies, and the abstinence violation effect	No	Counselors were trained and had weekly supervision meetings with a supervisor to ensure adherence to the intervention strategy using recorded counseling sessions	Tailored to mothers' stage of change	Counseling sessions were recorded. The MITIC was used to evaluate the counselor's adherence to the MI (overall rated as proficient to expert quality)
Mahabee-Gittens [47], 2008	5As and 5Rs	Face-to-face, telephone, and self-help materials	1 face-to-face session (10–15 min) at HCC and 1 telephone session (optional)	In the face-to-face session, parents were encouraged to quit smoking and their readiness to quit smoking was assessed. Parents who were interested in quitting in the next 6 months received a brief description of the state's quitline and were asked about interest in referral. Parents who did not want to be referred received tobacco cessation brochures	No	Counseling session was delivered by the principal investigator or trained clinical research coordinator. The quitline was delivered by counselors of the Ohio Quitline.	Parents who were called by the quitline received information and/or counseling that was tailored to their stage of change	No information
Ralston [42], 2008	Clinical Practice Guideline (Treating Tobacco Use and Dependence)	Face-to-face	1 message (>10 min) during a face-to-face session (>30 min)	An extensive antismoking message that included practical counseling with an emphasis on problem solving and inclusion of pharmacotherapy	Yes	A pediatric hospitalist who received smoking cessation counseling training from a certified tobacco educator	No information	No information
Ralston [49], 2013	MI and Clinical Practice Guidelines (Treating Tobacco Use and Dependence)	Face-to-face and self-help materials	1 face-to-face message (<10 min) during child's hospitalization	Parents received a brief message and self-help materials on smoking cessation, a referral card of the state quitline with a recommendation to call the quitline within 2 months, and age-appropriate written patient education and safety recommendations	No	A pediatric hospitalist who received training in smoking cessation counseling and MI from certified trainers	Tailored to the parent's stage of change	No information
Scheffers-van Schayck [24], 2019	MI	Telephone and self-help materials	6 telephone sessions (20 min) in 10 weeks	Multiple topics were discussed during the counselor-initiated telephone sessions (e.g., cravings) Parents received the self-help brochure on smoking cessation at the start of the counseling. This brochure included didactic information about smoking cessation, motivational messages, exercises, and tips	Yes	Counselor was thoroughly trained, experienced, and certified in delivering smoking cessation counseling	The counseling was tailored to the needs of parents (e.g., in the intensity of the topics). The brochure included relevant information for parents	The counselor followed a protocol on which topics to discuss during the sessions
Schuck [22], 2014	Cognitive behavioral skill-building and MI	Telephone and self-help materials	Up to 7 telephone sessions in 3 months (intake session: 30 min; follow-up sessions: 10 min)	Counselor-initiated telephone sessions and three tailored supplementary brochures on smoking cessation that provided motivational messages, didactic information, tips and advice, and "parent-relevant information" (e.g., effects of SHS on children)	Yes	Counselors of the Dutch national quitline received extensive training and had multiple years of experience	The brochures were tailored to parents by providing "parent-relevant information"	No information

Table 2 (continued)

First author [Ref], year	Theoretical base or rationale	Mode of delivery	Sessions, *n* (duration)	Short description	NRT	Training providers	Tailoring	Fidelity
Severson [32], 1997	No information	Self-help materials, face-to-face, and videotape	4 face-to-face sessions at the HCC	During the face-to-face sessions, women received self-help materials on detrimental health effects of SHS and hints for quit strategies, for example Mothers also received oral counseling (e.g., brief advice) A videotape was shown to mothers on potential adverse health effects of smoking and the benefits of quitting	No	Pediatricians and office nurses received training (45 min). Research staff regularly visited pediatrician offices to support the staff	The self-help materials at the four well baby visits were tailored to mothers' current smoking status	Some women were called to ascertain the provider's adherence to the protocol Chart data showed that the implementation of the protocol decayed over time
Winickoff [50], 2010	SLT, TMC, HBM, MI, and 5As	Face-to-face, telephone, and web-based	1 face-to-face session (15 min) and 1 phone call (optional)	The aim of the face-to-face counseling session was to encourage parents to accept smoking cessation support. In addition, letters were faxed to four health care professionals. Parents were offered proactive telephone counselling: If declined: encouraged to discuss quitting options with their health care professional, received contact information of the quitline and were encouraged to call the quitline If accepted but unavailable: received self-help materials on smoking cessation by mail If accepted and available: telephone counseling and a web-based cessation program were offered	No	Trained staff	Materials were tailored to parental smokers and to their personal circumstances and included stage-appropriate intervention techniques	No information
Yu [40], 2017	No information	First intervention: face-to-face Second intervention: face-to-face and text messages	Both: 3 face-to-face sessions at home Second intervention: additional text messages in upcoming months	This study had two intervention conditions Both interventions: face-to-face counseling on the consequences of SHS to infants, education on establishing a smoke-free home, and self-help materials Second intervention: parents received text messages on the risks of SHS for mothers and their infants. Fathers also received messages that encouraged them to quit smoking	No	Trained health care workers	No information	No information

Intervention characteristics were extracted only from reported intervention descriptions from the respective published effect papers or protocol/intervention development papers. HCC, health care center; HBM, Health Belief Model; MI, motivational interviewing; MITIC, Motivation Interviewing Treatment Integrity Code; NRT, nicotine replacement therapy; SCT, Social Cognitive Theory; SET, Social Ecological Theory; SHS, secondhand smoking; SLT, Social Learning Theory; TMC, Transtheoretical Model of Change; TPB, Theory of Planned Behavior.

bias assessment were resolved through discussion and, if necessary, by consulting a third author (R.O, or M.K.). Moreover, if important information was not reported in a given article, the authors of that study were contacted for additional information.

Statistical Analyses

To examine the effectiveness of smoking cessation interventions tailored to parents, meta-analyses were carried out by computing relative risks (RR; using random-effects meta-analyses and the Mantel-Haenszel method) in Review Manager (version 5.3). In addition, four pre-specified subgroup analyses and two sensitivity analyses were performed.

In order to include primary outcomes that were as consistent as possible, we selected 7-day PPA (or an outcome that most closely resembled 7-day PPA; e.g., 30-day PPA) if a study had multiple cessation outcomes. If outcomes were measured at multiple time points, we decided to include the outcome that was assessed at the latest follow-up, which conforms with other related meta-analyses [15, 20]. The cessation outcomes that were included in our meta-analyses were not always reported as the primary cessation outcomes in the selected studies (see Table 3 for the outcomes that were included in the meta-analysis). Because only a few studies carried out a biochemical validation and we preferred for the outcomes to be as consistent as possible, we chose not to include outcomes that were biochemically validated. If only the results of complete case analyses were reported in the studies, the results concerning the cessation rates were adapted (i.e., missing values at follow-up are recorded as "smoker"). Three of the included studies [23, 39, 40] were 3-arm RCTs that included two intervention conditions. Based on the *Cochrane Handbook for Systematic Reviews of Interventions* [41], we decided to combine the cessation rates of the two intervention conditions in the first two studies, since the rates did not significantly differ [39, 40]. With respect to the third study [23], the effectiveness of the smoking cessation intervention was only tested between two (and not three) conditions, so no adaptations had to be made. Two other included studies were cluster-RCTs [32, 33]. Based on the *Cochrane Handbook* [41], we decided to apply the intraclass correlation of 0.0009 for quitting, as reported by Severson et al. [32], to the results of the two cluster RCTs to verify for potential biases. To test heterogeneity, the I^2 statistic, the 95% confidence intervals (CI) of the effect sizes for each study, and the χ^2 test were inspected. If the χ^2 test was insignificant ($p > 0.05$), I^2 <30%, and the CIs overlapped, there was considered to be no heterogeneity. Funnel plots were created to explore potential publication bias and Egger's test and rank correlation tests were carried out to statistically test the possibility of publication bias. If the funnel plot was asymmetrical and the tests were significant ($p < 0.05$), there was considered to be publication bias.

With respect to the additional statistical analyses, four prespecified subgroup analyses were carried out based on prior research [15, 20]: (1) theoretical basis of the intervention (yes/no); (2) provision of NRT during the intervention (yes/no); (3) risk of bias judgement (low risk/some concerns/high risk), and (4) intervention received by parents in the control condition (passive/active). Moreover, to test whether the results of the meta-analysis were robust, sensitivity analyses were performed by replicating the analyses: (1) without the three studies for which the operationalization of the cessation rates was unclear [33, 40, 42], and (2) with the studies that also reported the results of the complete case analyses [22, 33, 40, 43–47].

Table 3. Classification of the 18 included studies for the subgroup analyses and risk of bias assessment

First author [Ref], year	Outcome included in meta-analysis	Theoretical basis of the intervention[1]	Provision of NRT during intervention	Intervention delivered to the control condition	Risk of bias
Abdullah [30], 2005	7-day PPA at 6-month FU	Yes	No	Active	Randomization: SC Blinding: SC Missing data: LR Measurement of the outcome: SC Selection of the results: SC Overall: SC
Borrelli [43], 2010	7-day PPA at 3-month FU	Yes	Yes	Active	Randomization: LR Blinding: SC Missing data: SC Measurement of the outcome: SC Selection of the results: SC Overall: SC
Borrelli [23], 2016	7-day PPA at 12-month FU	Yes	Yes	Active	Randomization: HR Blinding: SC Missing data: SC Measurement of the outcome: SC Selection of the results: SC Overall: HR
Caldwell [33], 2018	Quit status at 48-month FU	Yes	Yes	Active	Randomization: SC Blinding: SC Missing data: SC Measurement of the outcome: SC Selection of the results: SC Overall: SC
Chan [45], 2005	7-day PPA at 1 months FU	Yes	No	Passive	Randomization: SC Blinding: SC Missing data: LR Measurement of the outcome: SC Selection of the results: SC Overall: SC
Chan [48], 2008	7-day PPA at 12-month FU	Yes	No	Active	Randomization: LR Blinding: SC Missing data: SC Measurement of the outcome: SC Selection of the results: SC Overall: SC
Chan [44], 2017	7-day PPA at 12-month FU	Yes	Yes	Active	Randomization: SC Blinding: SC Missing data: SC Measurement of the outcome: SC Selection of the results: SC Overall: SC
Curry [46], 2003	7-day PPA at 12-month FU	Yes	No	Not reported[2]	Randomization: LR Blinding: SC Missing data: SC Measurement of the outcome: SC Selection of the results: SC Overall: SC
Groner [39], 2000	7-day PPA at 6-month FU	Yes	No	Passive	Randomization: SC Blinding: SC Missing data: SC Measurement of the outcome: LR Selection of the results: SC Overall: SC

Table 3 (continued)

First author [Ref], year	Outcome included in meta-analysis	Theoretical basis of the intervention[1]	Provision of NRT during intervention	Intervention delivered to the control condition	Risk of bias
Hannöver [31], 2009	4-week PPA at 24-month FU	Yes	No	Active	Randomization: SC Blinding: SC Missing data: LR Measurement of the outcome: SC Selection of the results: SC Overall: SC
Mahabee-Gittens [47], 2008	7-day PPA at 3-month FU	Yes	No	Passive	Randomization: HR Blinding: SC Missing data: SC Measurement of the outcome: SC Selection of the results: SC Overall: HR
Ralston [42], 2008	Quit status at 6 months FU	Yes	Yes	Active	Randomization: HR Blinding: SC Missing data: SC Measurement of the outcome: SC Selection of the results: SC Overall: HR
Ralston [49], 2013	≥7-day PPA at 2-month FU	Yes	No	Passive	Randomization: LR Blinding: SC Missing data: SC Measurement of the outcome: LR Selection of the results: SC Overall: SC
Scheffers-van Schayck [24], 2019	7-day PPA at 3-month FU	Yes	Yes	Active	Randomization: LR Blinding: SC Missing data: LR Measurement of the outcome: LR Selection of the results: LR Overall: SC
Schuck [22], 2014	7-day PPA at 12-month FU	Yes	Yes	Active	Randomization: LR Blinding: SC Missing data: LR Measurement of the outcome: SC Selection of the results: LR Overall: SC
Severson [32], 1997	7-day PPA at 12-month FU	Not reported	No	Active	Randomization: SC Blinding: SC Missing data: SC Measurement of the outcome: SC Selection of the results: SC Overall: SC
Winickoff [50], 2010	7-day PPA at 3-month FU	Yes	No	Passive	Randomization: SC Blinding: SC Missing data: SC Measurement of the outcome: SC Selection of the results: SC Overall: SC
Yu [40], 2017	Quit status at 12-month FU	Not reported	No	Passive	Randomization: LR Blinding: SC Missing data: SC Measurement of the outcome: SC Selection of the results: SC Overall: SC

FU, follow-up; HR, high risk; LR, low risk; NRT, nicotine replacement therapy; PPA, point-prevalence abstinence; SC, some concerns.

[1] Because little variance was found between the two subgroups, no subgroup analysis was performed.

[2] No information was provided on what parents in the control condition received in Curry et al. [46]. Therefore, this study was not included in the subgroup analysis.

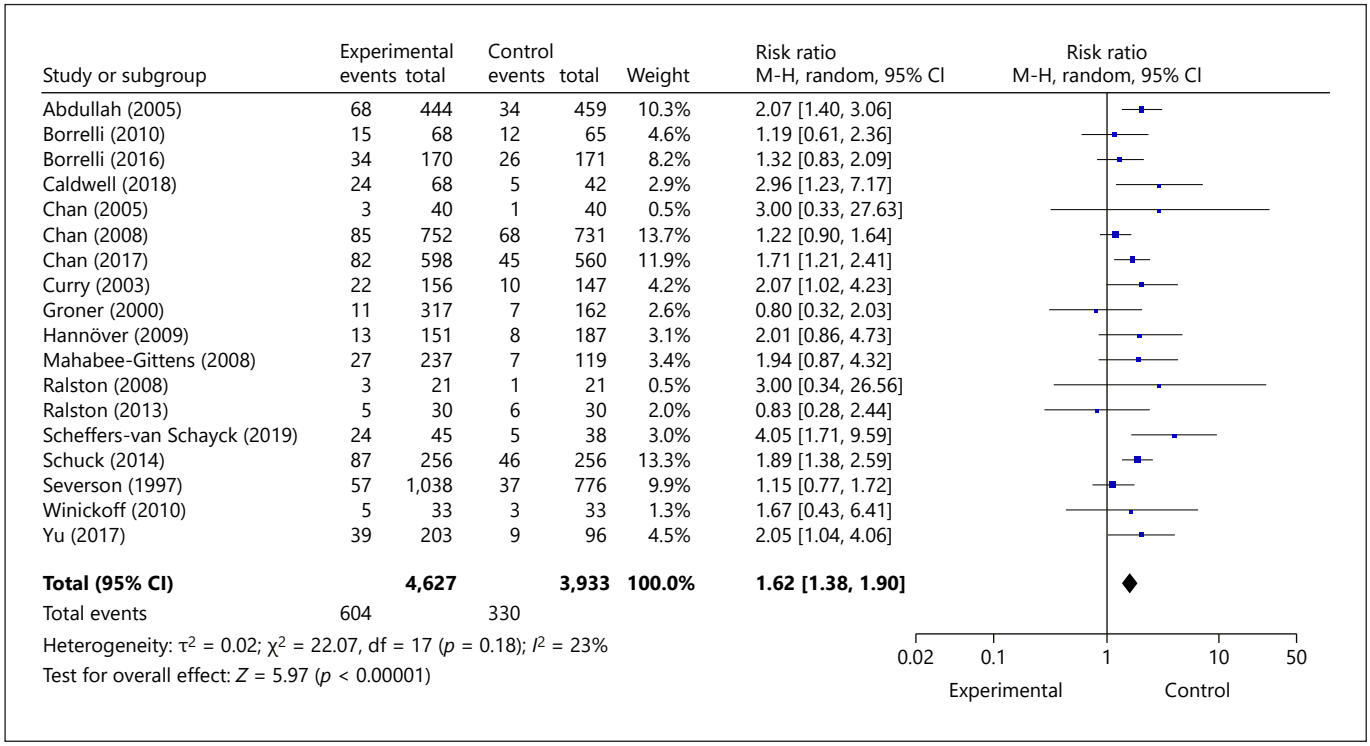

Fig. 2. Meta-analysis of RRs of the effects of smoking cessation interventions tailored to parents.

Results

Description of Included Studies

Table 1 provides an overview of the characteristics of the studies included in this meta-analysis. All 18 studies were RCTs, divided into 16 individual RCTs (of which two were pilot-RCTs [45, 47]) and two cluster-RCTs [32, 33]. Although most studies had two conditions, three studies had three conditions [23, 39, 40]. There were also some small differences in the recruitment settings used. In total, 13 studies recruited parents via a health care setting [30–32, 39, 40, 42, 44–50], two studies recruited parents via schools [22, 33], and three studies recruited parents via various settings [23, 24, 43]. In addition, the included studies differed by publication date (one before 2000 [32], eight between 2000 and 2009 [30, 31, 39, 42, 45–48], and nine in or after 2010 [22–24, 33, 40, 43, 44, 49, 50]), the country in which the studies were conducted (ten in the USA [23, 32, 33, 39, 42, 43, 46, 47, 49, 50], five in China [30, 40, 44, 45, 48], two in the Netherlands [22, 24], and one in Germany [31]), and the sample sizes (from 42 [42] to 2,901 parents [32]). Finally, the majority of studies focused on the smoking behavior of both fathers and mothers [22, 23, 24, 30, 33, 42, 43, 45, 47, 49, 50], while seven studies only focused on maternal (n = 4 [31, 32, 39, 46]) or paternal smoking behavior (n = 3 [40, 44, 48]).

Description of the Interventions

Table 2 presents an overview of the characteristics of the interventions that were examined in the included studies. The majority (n = 15) of the interventions were delivered face-to-face [23, 31–33, 39, 40, 42–45, 47–51]. All interventions included multiple sessions (face-to-face and/or telephone), except for three interventions that included only one session [39, 42, 49]. In addition, most interventions had a theoretical base or rationale. Only two studies did not report any information on this [32, 40]. In less than half (n = 7) of the interventions, parents received some form of NRT (or were encouraged to use NRT) [22–24, 33, 42–44]. Finally, 12 studies reported some information on tailoring of the intervention to parents [22, 24, 30–33, 43, 45, 47, 49–51].

Risk of Bias Assessment

The risk of bias assessment of the 18 included studies can be found in Table 3. Both the judgement for all criteria and the overall judgement are depicted. As illustrated

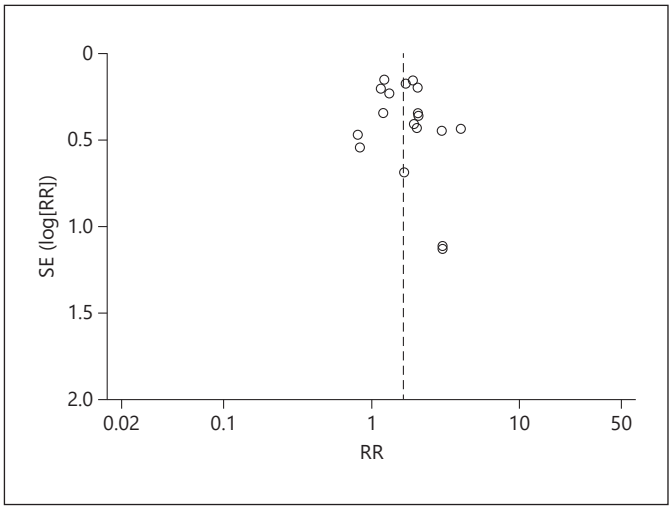

Fig. 3. Funnel plot of pooled effects of smoking cessation interventions tailored to parents.

in Table 3, 15 studies scored "some concerns." All three of the other studies scored "high risk" on the overall judgement because an urn randomization procedure was carried out [23] or because baseline imbalances were found on smoking-related variables between the conditions [42, 47].

Intervention Effects and Subgroup Analyses

The results of the meta-analysis are displayed in Figure 2. With a total number of 8,560 parents, the pooled RR was 1.62 (95% CI 1.38–1.90; $p < 0.00001$), showing a significant but modest effect. Overall, 13.1% of parents in the intervention conditions versus 8.4% of the parents in the control conditions reported smoking abstinence. The funnel plot did not show noteworthy deviations (Fig. 3). In addition, the Egger's test and the rank correlation test did not yield significant results (Egger's test: $p = 0.38$; rank correlation test: $p = 0.50$), indicating no risk of publication bias. Although heterogeneity was low ($I^2 = 23\%$; $\chi^2 = 22.07$; $p = 0.18$), pre-specified subgroup analyses were carried out. Results revealed no significant differences for provision of NRT during the intervention (yes: RR 1.79; 95% CI 1.40–2.29 vs. no: RR 1.49; 95% CI 1.22–1.83), risk of bias in overall judgement (some concerns: RR 1.64; 95% CI 1.37–1.98 vs. high risk: RR 1.48; 95% CI 1.00–2.20), and intervention delivered to the control condition (passive: RR 1.51; 95% CI 1.02–2.23 vs. active: RR 1.64; 95% CI 1.36–1.90). Eventually, no subgroup analysis was performed concerning the theoretical basis of the intervention, because little variance was found between the two subgroups (Table 3). The classification of the studies for the subgroup analyses can be found in Table 3. To test the robustness of the overall results, sensitivity analyses were performed by replicating the model without the three studies [33, 40, 42] of which the operationalization of the smoking cessation outcome was unclear. Results revealed a pooled RR of 1.57 (95% CI 1.33–1.86; $p < 0.00001$; $I^2 = 27\%$), indicating no substantial difference. The second sensitivity analysis, in which only studies were included that reported the results of the complete case analyses [22, 33, 40, 43–47], revealed a pooled RR of 1.79 (95% CI 1.29–2.47; $p < .00001$; $I^2 = 79\%$).

Discussion

This meta-analysis provides an overview of smoking cessation interventions tailored to parents of children and adolescents (aged 0–18 years). The overall results revealed that 13.1% of the parents in the intervention conditions reported smoking abstinence at follow-up compared to 8.4% of the parents in the control conditions. The pooled risk ratio showed that parents in the intervention conditions were 1.62 times more likely to quit smoking than parents in the control conditions, representing a significant but modest effect. Yet, small effect sizes can still have important implications [52]. Even though some of the included studies yielded higher effect sizes (e.g., Abdullah et al. [30], Hannöver et al. [31], Scheffers-van Schayck et al. [24], and Schuck et al. [22]), the overall results suggest that improvement of smoking cessation interventions tailored to parents is warranted.

Smoking cessation interventions tailored to parents might be improved by combining these interventions with a tobacco prevention intervention for children. If parents receive a smoking cessation intervention and are asked to provide antismoking socialization to their children (e.g., to talk to their children about their experiences with smoking), parents could experience less cognitive dissonance, for example, because their smoking status and their expressions of antismoking values to their children will match [53]. This hypothesis was supported in an RCT in which a relapse prevention intervention for parents who had quit smoking for ≥24 h was tested. Parents in the intervention condition were encouraged to provide antismoking socialization to their children whereas parents in the control condition received no treatment. Results showed that this intervention was effective in both the short and long term (3-year follow-up) [53, 54]. This finding corresponds to one of the studies

included in this meta-analysis, which examined an intervention that focused on both parental smoking cessation and prevention of children initiating smoking [33]. Its results showed that the self-reported abstinence rates of parents in the intervention condition significantly increased in the longer term (from 6% at end of the treatment/2-year follow up to 41% at the 4-year follow-up, $p < 0.001$). In addition, significantly more parents in the intervention condition reported abstinence compared to the parents in the control condition at the 4-year follow-up (41 vs. 13%, $p < 0.001$). Although the biochemical validation did not find significant differences between the two conditions at the 4-year follow-up, the authors suggested that the high abstinence rates of parents in the intervention condition at the 4-year follow-up could be explained by the fact that children were enrolled in a school- and home-based tobacco prevention intervention. Further research is needed to gain more insight into whether a smoking cessation intervention for parents in which they are also engaged in providing anti-smoking socialization to their children, or the combination of a smoking cessation intervention for parents and a school-based tobacco prevention intervention for children, could increase the abstinence rates of parents more than when parents only receive a smoking cessation intervention.

Although the overall results showed that the smoking cessation interventions tailored to parents had a modest effect in terms of smoking abstinence, some of the included studies that had lower risk of bias (i.e., no score of "high risk" and ≥1 score of "low risk" on any of the criteria of the risk of bias assessment) revealed higher effect sizes (e.g., Abdullah et al. [30], Hannöver et al. [31], Scheffers-van Schayck et al. [24], Schuck et al. [22], and Yu et al. (2017) [40]). These results indicate that not all included smoking cessation interventions have to be improved and that some of these interventions could be ready for implementation. It is important to examine how these interventions can be successfully implemented by investigating how parents can be reached and encouraged to accept and use the interventions. A related question concerns how the costs that parents possibly have to pay to receive the interventions could be reimbursed (e.g., by health insurance) so that more parents are able to accept these evidence-based interventions. A couple of the included studies in this meta-analysis reported information about the costs of the interventions. For example, in a study that was based on data from the USA, Severson et al. [35] reported that mothers had to pay up to USD 25 for the intervention. In contrast, Scheffers-van Schayck et al. [26] reported higher costs of the intervention in the Netherlands (range EUR 302.50–363). However, the amount that these parents actually had to pay for the intervention depended on their health insurance. In other studies, parents received NRT or the behavior counseling for free [22, 23, 43, 44, 49]. A Cochrane review showed that full reimbursement of smoking cessation interventions (vs. no reimbursement) increased the use of interventions, the number of quit attempts, and the abstinence rates at 6 months or longer [55]. In contrast, partial reimbursement versus no reimbursement did not significantly increase the use of smoking cessation interventions [55]. Thus, full reimbursement could increase the impact of smoking cessation interventions in its effectiveness and acceptance by smokers.

The pooled risk ratio of this meta-analysis corresponds to a large extent to the pooled risk ratio of 1.69 (95% CI 1.2–2.4, $p = 0.003$) that was found in a previous subgroup analysis [15]. However, in contrast to previous research [15, 20], we did not find any significant differences in the subgroup analyses concerning the provision of NRT during the intervention and the intervention that was delivered to the control condition (passive/active). These results could be explained by the fact that we included more studies and our studies primarily focused on parental smoking cessation (and not on reduction of exposure to SHS). Both sensitivity analyses yielded quite similar effect sizes compared to the effect size of the main analysis. The effect size of the first subgroup analysis (that excluded three studies for which the operationalization of the cessation rates was unclear) was smaller than the effect size of the main analysis (RR 1.57). The somewhat larger effect size (RR 1.79) of the second subgroup analysis (that only included complete cases) could be explained by the fact that this subgroup analysis did not include the cessation rates of parents who did not complete the follow-up assessment, therefore yielding a more positive (biased) image of the effectiveness of the interventions [56]. Yet, the fact that the results of the sensitivity analyses did not substantially differ from the results of the main analysis underlines the robustness of these results.

Limitations

This meta-analysis had several limitations. First, we were unable to include biochemically validated abstinence rates in our meta-analysis. Although guidelines recommend the use of biochemical validation [56], only 50% of the included studies validated abstinence rates biochemically. Because we aimed at having outcomes that were as consistent as possible, we decided to include only

self-reported abstinence rates. A second methodological limitation is that none of the included studies scored "low risk" on the overall judgement of the risk of bias assessment, while three studies scored "high risk," indicating that the results of the included studies (and therefore also the results of this meta-analysis) could have been biased. In particular, there is a possibility of selection bias in three of the included studies due to limitations in the randomization of parents to the interventions [23, 42, 47]. Therefore, caution is needed in interpreting the results of the present meta-analysis. In addition, the fact that all included studies scored at least "some concerns" on the overall judgement indicates that future research should be methodologically improved, and guidelines (e.g., the CONSORT statement [57]) should be followed in the reporting of future studies. Finally, although eight of the studies included only parents who smoked cigarettes [23, 39, 40, 43, 44, 46, 49, 50], in other studies it was not clear whether parents only smoked cigarettes or whether they also used other tobacco products (e.g., e-cigarettes [58]). Related to this, most studies did not report whether the interventions only aimed at stopping smoking cigarettes or if it also impacted the use of other tobacco products. This is a limitation as the smoke of other tobacco products also contains pollutants [59], which urges the need for knowledge about the effects of smoking cessation interventions on the use of other tobacco products as well.

Conclusion

To the best of our knowledge, this is the first meta-analysis on interventions that are primarily aimed at helping parents (of children and adolescents aged 0–18 years) to quit smoking. Although the results of this meta-analysis should be interpreted with caution and some of the included interventions yielded promising results, overall results suggest that smoking cessation interventions tailored to parents are modestly effective. Future studies should test which factors of smoking cessation interventions (with high effect sizes) make these interventions effective in terms of smoking abstinence. For instance, are interventions more effective when children of smoking parents experience smoking-related health problems? To increase the effectiveness and the impact of these interventions in terms of public health and controlling tobacco use, it is crucial for further research to explore how these interventions can be improved.

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Statement of Ethics

All studies that were included in the present meta-analysis provided information with approval by the institute's committee on human research and/or after obtaining active informed consent of the participants.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

T.S.-v.S. was responsible for the literature search, the data selection and extraction process, quality assessment, and reporting the study results. A.M. contributed to the data selection and extraction process and quality assessment. A.M., R.O., R.E., and M.K. reviewed and contributed to earlier versions of the manuscript. All authors read and approved the final manuscript.

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