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Parental Smoking Cessation to Protect Young Children: A Systematic Review and Meta-analysis

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KEY WORDS

parenting, second hand smoke, smoking cessation, systematic reviews, tobacco use/smoking

ABBREVIATIONS

AD—absolute difference
CI—confidence interval
CT—controlled trial
RCT—randomized controlled trial
RD—risk difference
RR—risk ratio

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abstract

FREE

BACKGROUND: Young children can be protected from much of the harm from tobacco smoke exposure if their parents quit smoking. Some researchers encourage parents to quit for their children's benefit, but the evidence for effectiveness of such approaches is mixed.

OBJECTIVE: To perform a systematic review and meta-analysis to quantify the effects of interventions that encourage parental cessation.

METHODS: We searched PubMed, the Cochrane Library, Web of Science, and PsycINFO. Controlled trials published before April 2011 that targeted smoking parents of infants or young children, encouraged parents to quit smoking for their children's benefit, and measured parental quit rates were included. Study quality was assessed. Relative risks and risk differences were calculated by using the DerSimonian and Laird random-effects model.

RESULTS: Eighteen trials were included. Interventions took place in hospitals, pediatric clinical settings, well-baby clinics, and family homes. Quit rates averaged 23.1% in the intervention group and 18.4% in the control group. The interventions successfully increased the parental quit rate. Subgroups with significant intervention benefits were children aged 4 to 17 years, interventions whose primary goal was cessation, interventions that offered medications, and interventions with high follow-up rates (>80%).

CONCLUSIONS: Interventions to achieve cessation among parents, for the sake of the children, provide a worthwhile addition to the arsenal of cessation approaches, and can help protect vulnerable children from harm due to tobacco smoke exposure. However, most parents do not quit, and additional strategies to protect children are needed. *Pediatrics* 2012;129:141–152

Tobacco, a legal product worldwide, killed 100 million people in the 20th century, and could kill as many as a billion human beings in the current century.[1] Efforts to prevent tobacco-related morbidity and premature mortality depend on prevention programs, policies protecting people from tobacco smoke exposure, and effective cessation programs. Over a decade ago, Peto and Lopez showed that cessation will contribute quickly to lowering the burden of smoking-induced disease, because of the immediate health benefits of quitting and the long lag time for the development of many smoking-related diseases.[2] Cessation has the additional benefit of the prevention of exposure of others to tobacco smoke. Yet, cessation for many smokers remains an elusive goal,[3(p.15)] with most quitters returning to their habit over time.[4]

Principles of behavior assume that the provision of knowledge works to change behavior when motivation for change is present. Increased perception of risk has been shown to be associated with healthier behaviors.[5] Common ignorance of the magnitude of damage from tobacco, in combination with the tendency of smokers to underestimate their personal risk,[6,7] suggests that the provision of accurate risk information may aid some smokers in quitting. Because this approach has been unsuccessful in convincing many smokers to quit for good, some researchers have considered an alternate track: They have focused on the health of others exposed to tobacco smoke rather than on the smoker's personal risk. This strategy may be particularly effective when the smoker considers the health of his/her own children, which affords several benefits: child health benefits due to lowered tobacco smoke exposure, including lowered risk of sudden infant death syndrome, middle ear disease, asthma, pneumonia, and compromised lung function[8]; possible reduced risk of future smoking among children of parents who have quit[9]; and benefits of quitting to parents themselves. An additional benefit, less well known, is the eventual removal of most third-hand smoke[10] from the homes of smokers, particularly when all smokers in the home quit permanently and do not allow visitors to smoke in the home.

The World Health Organization estimates that 40% of children worldwide are exposed to secondhand smoke.[11] A 2008 study showed very high median air nicotine concentrations in homes with smokers in 31 countries, and concluded that "women and children living with smokers are at increased risk of premature death and disease from exposure to SHS."[12]

The earliest published trial to encourage parental quitting for child protection[13] focused on protecting infants from tobacco smoke exposure, while emphasizing the benefits of quitting for the parents. This trial did not successfully affect tobacco smoke exposure or quit rates. Interventions tested since then aimed at families and caretakers have been implemented in physicians' offices, well-baby clinics, schools, and the community.[14] Some interventions have focused on getting parents to quit or reduce smoking, whereas others have focused on getting parents to protect their children from tobacco smoke exposure by moving their smoking and others' smoking behaviors away from the home, car, or child. Tools used to effect change have been both brief and of varying degrees of intensity, and have included cognitive behavioral approaches, self-help materials, individual counseling, and biofeedback.[14]

In this article, we present meta-analyses of parental quit rates from published intervention trials that were designed to protect children from tobacco smoke exposure through parental cessation or modification of parental smoking patterns, and that evaluated cessation among smoking parents of young children. To identify specific factors that might be associated with effective programs, we performed exploratory subgroup analyses on factors related to the child, the intervention, and the study methodology.

METHODS

Data Sources

We searched Medline, PsycINFO, Web of Science, and the Cochrane Library for articles published in English from any date through the end of March 2011. We used regular search terms for all databases, and also used Medical Subject Headings search terms for Medline.

Search terms used with all databases were: intervention to reduce environmental tobacco smoke children/preschool children/infants/newborn, intervention to reduce exposure of passive smoke in infant/children/preschool/newborn, reducing exposure passive smoking children/infants/newborn, the impact of a brief intervention on maternal smoking behavior, decreasing environmental tobacco smoke exposure among children/infants/newborn, advising parents on passive smoking, reducing tobacco smoke in the environment of the child, and intervention to reduce passive smoking in infancy.

The Medical Subject Headings search terms used were "smoking/prevention and control" AND "tobacco smoke pollution" OR "tobacco smoke pollution/prevention and control" AND "child", "smoking/prevention and control" AND "tobacco smoke pollution" OR "tobacco smoke pollution/prevention and control" AND "infant."

We were interested in original articles and reviews. We checked references in all retrieved review papers for additional related articles.

Data Extraction

Two reviewers (M.B.N. and T.B.) independently undertook extraction of study details and results. L.J.R. and M.B.N. independently assessed quality characteristics. We resolved differences between reviewers' extraction results by discussion.

Methodological Quality

The following parameters describing methodologic quality were assessed: study design (randomized controlled trial [RCT] using a cluster randomization scheme, RCT, quasi-RCT, controlled trial [CT]), randomization concealment (yes, no, or not reported), blinding of observers (yes, no, or not reported), biochemical validation of quit rates (yes, no), follow-up (percentage of follow-up at last time point measured), fidelity to treatment (percentage of participants receiving full intervention).

Study Eligibility

To be included, the studies had to meet the following criteria:

Study design: RCT using a cluster or individual-level randomization scheme, quasi-randomized RCT, CT.

Participants: Parents (mother, father or both parents) of children between the ages of 0 and 6 years in one of the following cohorts: well (including children visiting well-child clinics and population cohorts), asthmatic children, or children visiting hospitals or pediatric clinics. Trials that included children older than 6 years were acceptable only if children 6 years old or less were eligible for inclusion.

Types of interventions: Unrestricted.

Program providers: Unrestricted.

Study objectives: Primary goal must have been either reduction or cessation of parental smoking to benefit children, or child tobacco smoke exposure reduction.

Study outcome: Quit rates of parents, mothers, or fathers must have been monitored.

Length of observation period: Minimum 1 month from start of intervention.

Study Outcomes

Our primary outcome was parental quit rate. If a biochemically validated quit rate was available, that was used in the analysis; otherwise, parental report was used. We present (1) the parental quit rate (both parents if available, or maternal quit rate if that is the only measure available; no studies had paternal rates without maternal or parental rates), (2) the maternal quit rate, and (3) the paternal quit rate.

Quit rates at different follow-up times were sometimes presented in the same report. In these instances, we used the quit rate representing the longest available period.

Subgroup Analyses

We performed exploratory subgroup analyses on the parental quit rate by using the following categorizations:

Child-Related Subgroups

Child age at recruitment (<1 year, 1–4 years, 4+ years), child cohort (well, asthmatic, hospital, or clinic visit).

Intervention-Related Subgroups

Intervention setting (hospital, usual care physician's office, well-baby care setting, and family home), provider (physician, nurse, clinic staff, and research assistant), use of cessation medication (yes, no), and number of sessions (1, 2, 3–4, 5+)

Study-Related Subgroups

Use of theory in developing the intervention (none, theory-based); primary research objective (parental or maternal cessation, cessation and reduction of child exposure, reduction of child exposure to tobacco smoke), length of maximum follow-up (<6 months, 6 months, and >6 months), use of cessation medication (yes, no), provision of cessation or smoking-related intervention to the control group (yes/no).

Study Quality-Related Subgroups

Study design (cluster RCT, individually RCT, CT); blinding of observers (yes, no, or not reported), follow-up of participants (61%–80%, 81%–100%), fidelity to treatment. Because of the lack of reported information on fidelity for most studies, we were unable to perform this subanalysis.

Statistical Analysis

Meta-analytic Approach

Statistical analyses and meta-analyses were performed with the use of RevMan 5.0.24. We used the DerSimonian and Laird random-effects method with 95% confidence intervals to pool results.[15] We chose to use the random-effects method because we assumed that different intervention conditions would be associated with different effects, and we were interested in getting an average of the distribution of true effects from the population of intervention studies (as opposed to an estimate of a single-population effect, as would be the case were we to use the fixed-effects method).[16]

We present risk ratios (RRs) and risk differences (RDs) for the primary analyses, as well as risk ratios for the subgroup analyses. All measures are presented with 2-sided 95% confidence intervals.

Pooled quit rates for each group were calculated. Weights used to pool the data, obtained from RevMan, were based on the inverse variance method (weights proportional to the inverse variance of estimate), and adjusted for the random effects assumption.[16 (p.128)]

Heterogeneity and Publication Bias

We used the I^2 statistic to investigate statistical heterogeneity. This describes the percentage of the variability in effect estimates that is due to heterogeneity rather than sampling error (due to chance).[17] The existence of publication bias was checked by visual examination of funnel plots.[16]

Exploratory Subgroup Analyses

We performed exploratory analyses to understand whether some settings or conditions were clearly associated with intervention effects, as well as to see if heterogeneity could be explained. We determined that the intervention was significant in a particular subgroup if the results were statistically significant at the corrected Bonferonni .05 level. Because the numbers of studies and individuals within subgroups varied, it would have been misleading to directly compare across subgroups.[16] (p. 141, Section 8.8.2)

RESULTS

Description of Studies

Out of a total of 876 articles identified initially, 468 articles were screened. Of these, 403 articles concerned topics not relevant to this study, and 18 met the inclusion criteria for this review.[13,18–34] The trials were conducted in the United States, China, Norway, Scotland, Finland, Italy, and Australia between 1987 and 2010. Forty-seven studies were excluded for the following reasons: quit rates were not reported or were not reported separately for intervention and control groups, or numbers of participants were not reported (24 studies[35–58]; the study design was not a controlled trial [11 studies[59–69]]), the interventions were not aimed at parents of young children (9 studies[70–78]); the reporting period was less than 1 month (1 study[79]); a protocol only was reported (1 study[80]); the report was not in English (1 study[81]). The flowchart describing the identification process can be found in Fig 1. Study characteristics of included trials are presented in Table 1.

Intervention Components

Interventions included some of the following components: self-help materials (12 studies[13,18,20–22,24,26,29–31,33,34]), face-to-face counseling (16 studies[19–34]), telephone counseling (6 studies[13,18–20,32,34]), cessation medications (2 studies[24,28]), and cotinine feedback (1 study[32,39]). Three studies included one component ([23,25,27]), 12 studies included 2 components ([13,18,19,21,22,26,28–31,33,34]), and 3 studies included 3 components ([20,24,32]).

Age of Children

Six of the studies enrolled infants up to a year old,[13,21,22,29,30,34] and 12 of the studies enrolled children up to 16 years old.[18–20,23–28,31–33]

Child Cohort

Ten of the studies enrolled healthy children,[13,18,21,22,24,26,29,30,33,34] five of the studies enrolled asthmatic children,[23,25,27,31,32] and three of the studies enrolled children visiting hospitals or pediatric clinics.[19,20,28]

Setting

The intervention setting was the family home in 5 studies,[22–24,27,34] the hospital in 4 studies,[13,19,28,32] the well-baby clinic in 4 studies,[18,26,30,33] the pediatrician's office in 3 studies,[20,21,31] the hospital and well-baby clinic in 1 study,[29] and the hospital and family home in 1 study.[25]

Program Providers

Nurses were the intervention providers in 6 studies,[19,20,22,25,30,33] physicians were providers in 3 studies,[26,28,29] research assistants were providers in 7 studies,[13,18,23,24,27,31,32] and clinic

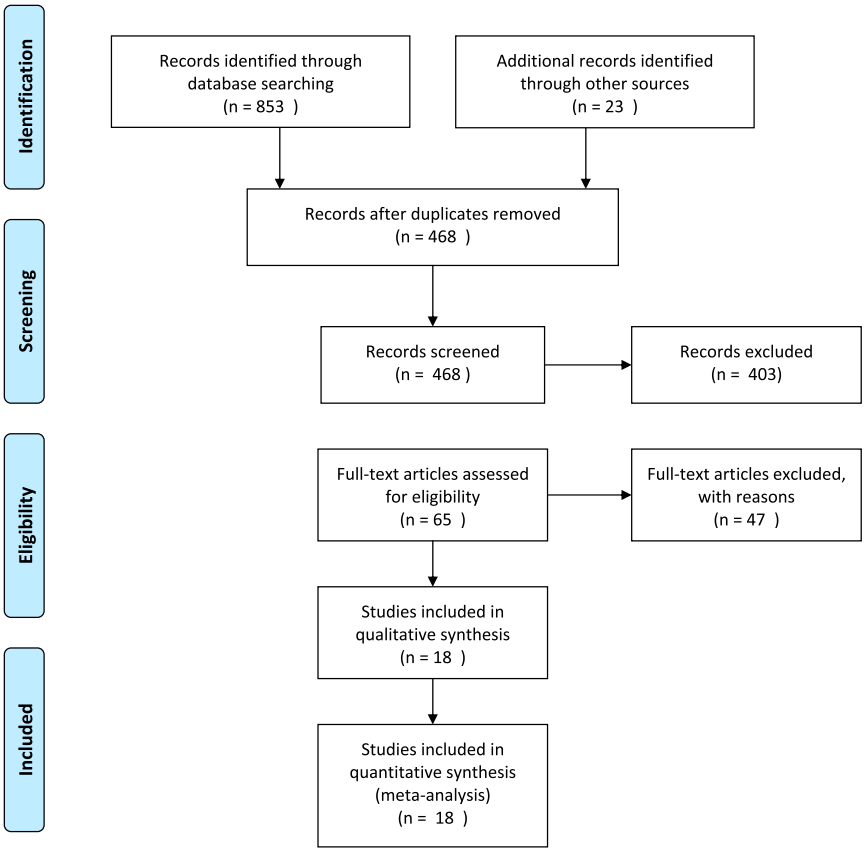

FIGURE 1
Flowchart for identification of studies.

TABLE 1 Characteristics of Included Studies

Study	Age at Recruitment	Child Cohort	Setting	Provider	No. of Sessions	Theory Based	Length of Observation	Primary Goal	Intervention Components
Abdullah et al[18] (2005)	5 y	Well	Well-baby clinic	Research assistant	3	Yes	6 mo	Cessation	A,C
Chan et al[19] (2005)	Children	Hospital / clinic visit	Hospital	Nurse	1	No	1 mo	Cessation	B,C
Curry et al[20] (2003)	Children	Hospital / clinic visit	Pediatric	Nurse	4	No	12 mo	Cessation	A,B,C
Eriksen et al[21] (1996)	6 wk, 2, 4 y	Well	Pediatric	Clinic staff	1	No	1 mo	Reduction, cessation	A,B
Greenberg et al[22](1994)	<6 mo	Well	Home	Nurse	4	Yes	6 mo	Reduction	A,B
Hovell et al[23] (2002)	3-17 y	Asthmatic	Home	Research assistant	7	Yes	12 mo	Reduction	B
Hovell et al[24] (2009)	<4	Well	Home	Study counselor	14	Yes	18 mo	Reduction, cessation	A,B,D
Hughes et al[25] (1991)	6-16 y	Asthmatic	Hospital and family home	Nurse	4	No	12 mo	Reduction	B
Kallio et al[26] (2006)	5 mo	Well	Well-baby clinic	Physician	16	No	8 y	Reduction, cessation	A,B
Krieger et al[27] (2005)	4-12 y	Asthmatic	Home	Research assistant	5–9	No	12 mo	Reduction	B
Ralston and Rooh[28] (2008)	Children	Hospital / clinic visit	Hospital	Physician	1	Yes	6 mo	Cessation	B,D
Severson et al[29] (1997)	<6 mo	Well	Hospital & well-baby clinic	Physician	4	No	12 mo	Reduction, Cessation	A,B
Vineis et al[30] (1993)	0-3 mo	Well	Well-baby clinic	Nurse	NR	No	2 y	Cessation	A,B
Wahlgren et al[31] (1997)	6-17 y	Asthmatic	Pediatric	Research assistant	6	Yes	2 y	Reduction	A,B
Wilson et al[32] (2011)	3-12 y	Asthmatic	Home	Research assistant	6	Yes	12 mo	Reduction	B,C,E
Woodward et al[13] (1987)	Newborn	Well	Hospital	Research assistant	1	No	3 mo	Reduction	A,C
Yilmaz et al[33] (2006)	<16 y	Well	Hospital	Nurse	1	No	6 mo	Reduction, cessation	A,B
Zakarian et al[34] (2004)	<4 y	Well	Home	Clinic staff	7	Yes	12 mo	Reduction	A,B,C

[a] A, self-help materials; B, counseling; C, phone support; D, medication; E, biochemical feedback.

staff provided the intervention in 2 studies.[21,34]

Use of Medicine

Two of the 18 studies reported the use of cessation medication.[24,28]

Number of Sessions

In five of the studies only 1 session was given,[13,19,21,28,33] in five of the studies 3 to 4 sessions were given,[18,20,22,25,29] and in seven of the studies more than 5 sessions were given.[23,24,26,27,31,32,34] In one study, the number of sessions was not reported.[30]

Theoretical Basis

Nine of the studies used theory-based interventions.[18,19,22–24,28,31,34] Of these, 3 studies used learning theory interventions.[22–24] Nine studies did not mention the use of theory.[13,20,21,25–27,29,30,33]

Primary Goal

The study objective was reduction of child exposure in 8 studies,[13,22,23,25,27,31,32,34] maternal cessation in 5 studies,[18–20,28,30] and both reduction of child exposure and maternal cessation in 5 studies.[21,24,26,29,33]

Length of Observation

The observation period was less than 6 months in 3 studies,[13,19,21] 6 months in 3 studies,[18,28,33] 12 months in 8 studies,[20,22,23,25,27,29,32,34] and more than 12 months in 4 studies.[24,26,30,31]

Control Group Intervention

In eight of the studies, the control group received some sort of intervention (usual care or special to the trial) related to smoking, cessation, or risk to children from smoking.[18,21,23,25,27–29,32] In four of the studies, the control group did not receive any information on the topic of cessation or reduction of child exposure, in usual care or as a special intervention.[19,24,26,33] In the remainder of the studies, we were unable to

determine what the control group received.[13,20,22,30,31,34]

Methodologic Quality

The characteristics of the studies pertaining to methodological quality are presented in Table 2. Of the 18 studies, one used a cluster randomized design,[29] fourteen used an individually randomized design,[18–24,26–28,31–34] two used a quasi-randomized design,[13,25] and one used a controlled but not randomized design.[30] Nine of the studies reported randomization concealment.[18–21,23,24,27,32,33] In the remainder of the studies, concealment was not reported or was unclear. Blinding of observers/assessors was reported in seven of the trials.[18,19,22,23,32–34] Biochemical validation of quit status was reported in five of the trials.[13,18,20,23,34] Percentage of follow-up ranged from 61% to 97%. Five studies had follow-up of greater than 90%,[19,23,25,32,33] and 13 studies had follow-up of greater than 80%.[13,18–21,23–25,30–34] Information on fidelity to treatment was addressed in a minority of trials.[13,22–25,30] Two studies reported very high fidelity to treatment (Greenberg, 97%[22]; Hovell 2002, 98%[23]), and 1 study provided in-depth information on fidelity to various program components (Hovell 2009[24]).

Effects of Interventions (Main Effects)

Effects of Interventions on Parental, Maternal, and Paternal Quit Rates

Eighteen studies, with a combined N of 7053, are included in this analysis.[13,18–34] Results from each trial are summarized in Table 3 and Fig 2. Parental quit rates in individual studies ranged from 0.9% to 83.6% in the intervention group, with a weighted mean of 23.1%, and from 0.8% to 72.1% in the control group, with a weighted mean of 18.4%.

A positive effect of the intervention was found in thirteen (72%) of the studies, with four (22%) showing a statistically significant advantage to the intervention group. RRs ranged from 0.14 to 29.43. Overall, the RR was 1.34 (confidence interval [CI] 1.05,1.71; $P = .02$), showing a modest but statistically significant improvement in the intervention group. The RD of 0.04 (CI 0.01,0.07; $P = .005$) showed that an additional 4% of the intervention parents quit smoking than did control parents.

The pooled analyses of maternal quit rate (N = 12 trials) were similar to the results of parental quit rate. (RR = 1.44; CI 0.99,2.09; $P = .06$). A positive or significant effect of the intervention was not found in either of the 2 studies that examined paternal quit rates, nor was there a difference in the pooled RR (RR = 0.95; CI 0.71,1.29; $P = .76$).

Publication Bias

The funnel plot showing the SE of the log (RR) versus the RR is presented in Fig 3. As expected, higher RRs are associated with lower variance. The reasonably symmetrical plot shows that publication bias is not a concern.

Heterogeneity of Results

The test for heterogeneity was significant for the RR ($I^2 = 60\%$; $P = .0006$) and RD ($I^2 = 82\%$; $P < .001$), indicating that the results were not homogeneous.

We examined heterogeneity by subgroups. Sixteen subgroups (41% of all subgroups) had nonsignificant levels of heterogeneity: I^2 ranged from 0% to 56%, with P values ranging from 0.08 to 0.97. The other 23 subgroups

TABLE 2 Methodologic Characteristics of Included Studies

	Size	Design (RCT/CT/ Cluster CT)	Randomization Concealment (Yes, No, NR)	Blinding of Observers (Yes, No, NR)	Biochemical validation of outcome data (Yes/No))	Follow-up, %	Participants Received Full Intervention (%, NR)
Abdullah et al[18] (2005)	952	RCT	Yes	Yes	Yes	88	NR
Chan et al[19] (2005)	80	RCT	Yes	Yes	No	96	NR
Curry et al[20] (2003)	303	RCT	Yes	NR	Yes	81	NR
Eriksen et al[21] (1996)	443	RCT	Yes	NR	No	82	NR
Greenberg et al[22](1994)	933	RCT	NR	Yes	No	71	96
Hovell et al[23] (2002)	204	RCT	Yes	Yes	Yes	97	98
Hovell et al[24] (2009)	150	RCT	Yes	Yes	No	87	54
Hughes et al[25] (1991)	95	Quasi-RCT	No	NR	No	94	NR
Kallio et al[26] (2006)	1062	RCT	No	No	No	61	NR
Krieger et al[27] (2005)	274	RCT	Yes	No	No	78	NR
Ralston and Roohi[28] (2008)	42	RCT	No	NR	No	67	NR
Severson et al[29] (1997)	2901	Cluster RCT	No	No	No	69	NR
Vineis et al[30] (1993)	1015	CT	No	NR	No	82	NR
Wahlgren et al[31] (1997)	91	RCT	No	NR	No	87	NR
Wilson et al[32] (2011)	519	RCT	Yes	Yes	No	95	NR
Woodward et al[13] (1987)	184	Quasi-RCT	No	NR	Yes	85	NR
Yilmaz et al[33] (2006)	375	RCT	Yes	Yes	No	97	NR
Zakarian et al[34] (2004)	150	RCT	No	Yes	Yes	85.3	72

NR, not reported.

TABLE 3 Effects of Intervention Programs on Quit Rate by Intervention Group, With Risk Ratios, for Each Included Trial

	Size	Quit Rate Intervention, %	Quit Rate Control, %	Risk Ratio (CI)
ALL				1.34 (1.05,1.71)
Abdullah et al[18] (2005)	952	15	7	2.07 (1.40,3.06)
Chan et al[19] (2005)	80	8	3	3.00 (0.33,27.63)
Curry et al[20] (2003)	303	14	7	2.07 (1.02,4.23)
Eriksen et al[21] (1996)	443	0	3	0.14 (0.02,1.16)
Greenberg et al[22](1994)	933	1	3	0.30 (0.08,1.08)
Hovell et al[23] (2002)	204	8	9	0.88 (0.35,2.18)
Hovell et al[24] (2009)	150	17	5	3.16 (1.08,9.26)
Hughes et al[25] (1991)	95	13	8	1.53 (0.46,5.08)
Kallio et al[26] (2006)	1062	20	20	0.99 (0.78,1.27)
Krieger et al[27] (2005)	274	84	72	1.16 (1.00,1.34)
Ralston and Roohi[28] (2008)	42	14	5	3.00 (0.34,26.56)
Severson et al[29] (1997)	2901	5	5	1.13 (0.73,1.76)
Vineis et al[30] (1993)	1015	12	11	1.11 (0.70,1.75)
Wahlgren et al[31] (1997)	91	21	4	5.57 (0.72,43.22)
Wilson et al[32] (2011)	519	16	11	1.51 (0.86,2.63)
Woodward et al[13] (1987)	184	6	2	2.70 (0.29,25.04)
Yilmaz et al[33] (2006)	375	24	1	29.43 ([4.07,213.01)
Zakarian et al[34] (2004)	150	10	13	0.76 (0.29,2.00)

had statistically significant levels of heterogeneity.

Subgroup Analyses

Results from the analyses by subgroup are presented in Table 4. The relative risks ranged from 0.42 to 3.13, and the relative differences from −0.03 to 0.11.

The interventions were beneficial in the following subgroups: parents whose children were 4 years old and over (RR = 1.57; CI 1.14,2.16; P = .006); interventions that included use of cessation medication (RR = 3.13; CI 1.19,8.21;, P = .02); interventions whose primary purpose was cessation (RR = 1.69; CI 1.2,2.4; P = .003); and interventions whose follow-up was 81% to 100% (RR = 1.64; CI 1.12,2.42; P = .01).

DISCUSSION

Our review shows that interventions aimed at increasing parental cessation to benefit children increase parental and maternal quit rates.

To the best of our knowledge, this is the first meta-analysis to quantify the effect of interventions aimed at increasing cessation among parents of small children. The strategy of quitting for the sake of the children carries several benefits: Adults who quit smoking improve their own health and life expectancy[82]; their children are no longer exposed to the harmful effects of parental tobacco smoke; parents are freed from the worry that they may be harming their children by smoking in their presence; and children of nonsmokers may be less likely to initiate smoking.[9] As previously noted,[83] encouraging cessation for the sake of protecting others' health, particularly children's health, is an important means of combating use.

Our finding of a 4% absolute difference (AD) between parental quit rates in the intervention and control groups compares reasonably well with absolute differences from other recommended methods of encouraging cessation, including brief physician advice (AD = 2.5%), group counseling (AD = 3.1%), and individual counseling

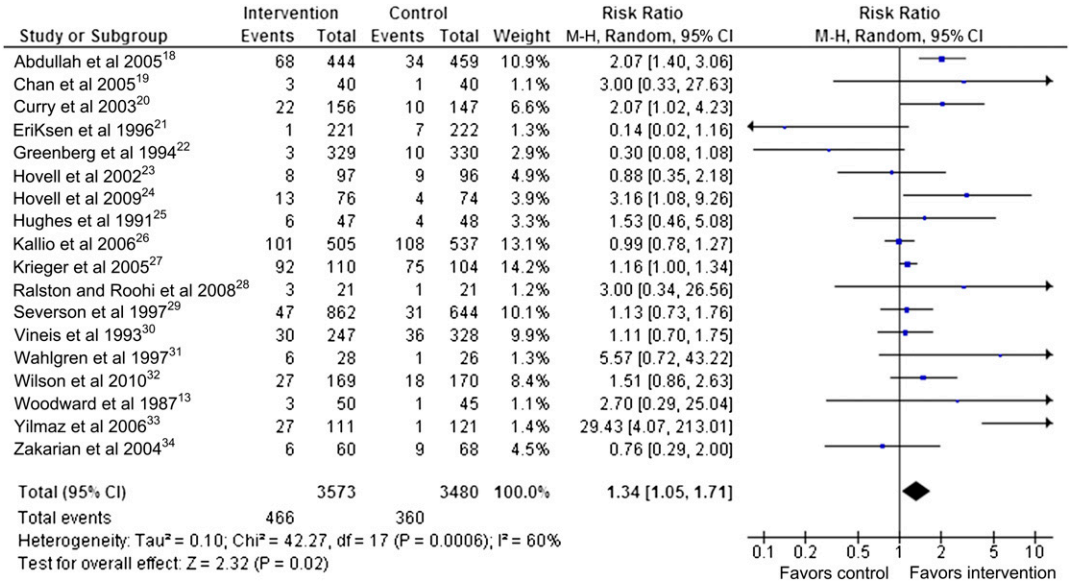

FIGURE 2
Meta-analysis of relative risks of the effects of interventions on parental cessation.

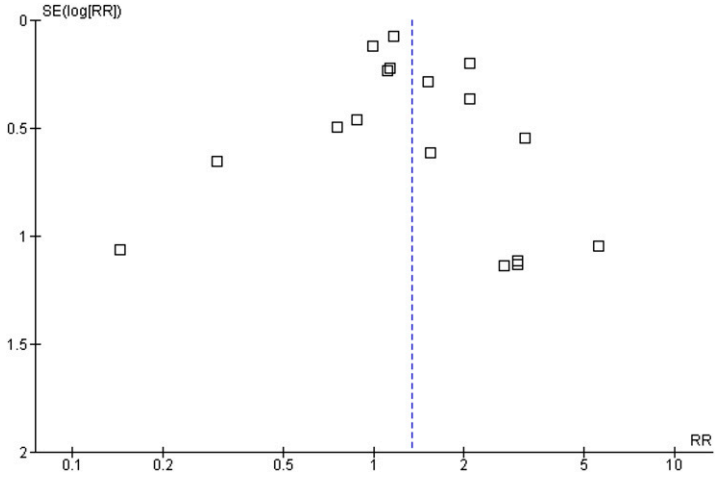

FIGURE 3
Plot to assess presence of publication bias.

(AD = 6.0%).[84(p. 88-90, Tables 6.8 and 6.13)] Because none of the known cessation approaches reach all smokers or have high success rates, additional effective cessation approaches, such as cessation for the sake of one's children, can impact population smoking rates.

Over three-quarters of parents in both intervention and control groups continued to smoke, leaving the overwhelming majority of children potentially exposed to their parents' smoke.

The observed degree of heterogeneity between the results from different studies reveals that not all types of interventions for promoting parental cessation are equally or necessarily effective. In the next section, we focus on promising findings from particular subgroups in an attempt to gain insight regarding possible future research and practice directions.

SUBGROUP ANALYSES

Interventions were effective with children over the age of four. The question of age and intervention effectiveness was raised more than 2 decades ago by Woodward, who targeted parents of newborns in his program, in the belief that those parents may be open to lifestyle change to protect their vulnerable infants. However, his intervention was not effective. He hypothesized that this was because "there was little awareness of risks to the baby from smoking postnatally" and because the mothers wanted to return to smoking after pregnancy. Another possible explanation, from a qualitative study that investigated why mothers continue to smoke around their children, is that "… [these interventions] require mothers to change their caring routine and behaviors at a time when many mothers feel that they are barely coping with existing responsibilities."[85]

Interventions that included the use of medications were effective. Of the 2 included studies in which medications were used, both offered nicotine replacement therapy. One of these was a small study (N = 42)[28] that included parents of hospitalized children with respiratory illness. The second was a somewhat larger study (N = 150)[24] that took place in the home.

Interventions with a primary purpose of getting parents to quit were effective. This may have been influenced by recruitment bias. Previous investigators described difficulties in recruitment and retention of participants in interventions dealing solely with cessation.[54] It is possible that "hardcore" smokers would be unlikely to participate in an intervention aimed only at cessation, but would be willing to participate in an intervention focusing on child protection through changes in patterns of smoking (eg, smoke-free homes and cars). This could lead to better cessation results in those interventions that focus on cessation only.

COMPARISON WITH OTHER REVIEWS

Two previous reviews addressed parental cessation; both of these were conducted using narrative synthesis. Klerman studied maternal cessation and found that most interventions had small but significant effects.[86] Gehrman and Hovell studied the effects of minimal clinical interventions on cessation, and found no significant effect.[87] They noted the original studies' small sample sizes and consequent low power to detect small but clinically important effects. The meta-analysis reported in this article overcomes this problem.[16 (p.98)]

LIMITATIONS AND FUTURE DIRECTIONS

Most included trials were truly randomized, and most had low attrition; these factors contribute to high internal validity of most individual trials. Randomization concealment and blinding of observers were not reported for most trials. If randomization was not concealed, or observers not blinded, the internal validity of individual studies may have been compromised. Adherence to principles of good study design, including implementation and reporting of randomization concealment, blinding of observers, and high fidelity to treatment,[88] will enhance the usefulness of future work.

An analysis of all studies together showed a significant amount of heterogeneity between trial results. Some of the heterogeneity was due to differences between subgroups: When heterogeneity was examined within subgroups,

TABLE 4 Effects of Intervention Programs on Parental Quit Rate Stratified According to Child-Related, Intervention-Related, and Design-Related Subgroup

Analysis	RR (CI)	*P**	No. of Studies	No. of Participants
Age				
Infants (0-1 y)	0.99 (0.6, 1.63)	.98	7	3556
Preschool (2-4 y)	1.14 (0.48, 2.68)	.77	4	1060
Children (4-17 y)	1.57 (1.14, 2.16)	.006*	11	3497
Child cohort				
Well	1.26 (0.83, 1.92)	.29	710	5733
Asthmatic	1.20 (1.00, 1.44)	.05	5	895
Hospital/clinic visit	2.21 (1.16, 4.23)	.02	3	425
Setting				
Well-baby clinic	1.46 (0.92, 2.33)	.11	5	4258
Hospital	1.28 (0.86, 1.90)	.22	5	1818
Pediatric clinic	1.30 (0.23, 7.40)	.77	3	800
Family home	1.16 (0.83, 1.63)	.39	7	1778
Provider				
Nurse	1.69 (0.73, 3.89)	.22	6	1944
Physician	1.04 (0.84, 1.28)	.75	3	2590
Research assistant	1.63 (1.06, 2.50)	.03	7	1948
Clinic staff	0.42 (0.09, 2.10)	.29	2	571
Use of theory in intervention development				
No theory	1.23 (0.93, 1.62)	.14	9	4505
Theory based	1.45 (0.92, 2.30)	.11	9	2548
Use of medicine				
Yes	3.13 (1.19, 8.21)	.02*	2	192
No	1.28 (1.00, 1.63)	.05	16	6861
Length of observation				
<6 mo	1.47 (0.59, 3.66)	.41	6	1091
6 mo	2.74 (0.8, 9.42)	.11	4	1305
12 mo	1.15 (0.87, 1.52)	.33	8	3434
2+ y	1.32 (0.82, 2.10)	.25	4	1821
Primary goal				
Maternal cessation	1.69 (1.2, 2.40)	.003*	5	1903
Reduction of child exposure	1.14 (0.84, 1.55)	.39	8	1777
Reduction of child exposure and maternal cessation	1.51 (0.73, 3.13)	.27	5	3373
Study design				
RCT	1.40 (1.01, 1.92)	.04	14	4782
Quasi-RCT	1.74 (0.61, 5.00)	.3	2	190
CT	1.11 (0.70, 1.75)	.66	1	575
Cluster RCT	1.13 (0.73, 1.76)	.58	1	1506
No. of sessions				
1	2.56 (0.44, 14.78)	.29	5	892
3-4	1.38 (0.84, 2.27)	.21	5	3466
>5	1.16 (0.94, 1.44)	.17	7	2120
Control group received related intervention				
Yes	1.27 (0.91, 1.79)	.16	7	3396
No	2.25 (1.02, 4.98)	.04	5	1843
Percentage follow-up				
60-80	1.07 (0.86, 1.32)	.55	5	3463
81-100	1.64 (1.12, 2.42)	.01*	13	3590
Blinding of assessors				
Yes	1.56 ([0.87, 2.82)	.14	8	2684
No	1.11 (0.99, 1.26)	.08	3	2762
Not reported	1.49 (0.85, 2.59)	.16	7	1607

* P value is significant at the Bonferroni-corrected .05 2-sided level.

nearly 40% of the subgroups had low levels of heterogeneity. Because of the use of a random-effects model, the discovered heterogeneity did not affect the validity of the average effect calculated.

Because of the large number of variables of interest relative to the total number of trials, we were not able to analyze possible interactive effects of intervention and child-related variables.

Time and resources did not permit outreach to authors of excluded studies with missing data.

Further original research is needed to develop more effective programs for getting parents to quit smoking. This may be enhanced by phased development of interventions,[89] beginning with in-depth qualitative research with parents and including intervention piloting.

CONCLUSIONS

Some parents will quit smoking to benefit their children. Policy makers should recommend effective interventions that counsel parents to quit for the benefit of the children, and recommend training of clinicians in this area. More research is needed to build effective interventions for encouraging parental cessation for the benefit of children, to isolate components that best maximize the motivating function of child welfare, and to identify effective interventions for the protection of children from tobacco smoke exposure if parents are not ready or able to quit.

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RECHARGING THE WELL: *How long can one pump water from an aquifer before it runs dry? The question seems a bit like a high school math problem, but the answers are not known and the implications are enormous. Aquifers are wet underground layers of rock or sediments from which water can be extracted by a well. For years, scientists have not had a good way to measure how fast aquifers are recharged by surface water. Commonly used dating tools, such as carbon 14, have been useful in archeology but not so much in understanding the flow of underground water. Now scientists have reported a breakthrough in dating technology using krypton 81. As reported in* The New York Times *(Science: November 21, 2011), krypton 81 is an isotope present in air. Once trapped underground in water that no longer has contact with air, krypton 81 begins to decay by a factor of two every 230,000 years. Capturing krypton 81 is extremely challenging as there is only one molecule of krypton 81 for every quintillion (10^{18}) water molecules. Using sophisticated technology, scientists were able to capture and measure krypton 81 in water samples obtained from deep in the Nubian Aquifer. The results suggest that the Nubian Aquifer has been collecting water for millions of years. The bad news is that the aquifer probably only recharges a little each year; thus, under normal circumstances the water level may only rise a few millimeters a year. While the aquifer still contains a massive amount of water, it is shared by four countries: Egypt, Libya, Chad, and Sudan. Rapid or heavy pumping could lead to both local and international conflicts. Already, some lakes and oases supplied by the aquifer are now dry. While water management is often a political rather than scientific issue, better understanding of the hydrology may make it easier to develop and adhere to water management plans.*

Noted by WVR, MD

Parental Smoking Cessation to Protect Young Children:A Systematic Review and Meta-analysis

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