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Reducing Maternal Smoking and Relapse: Long-Term Evaluation of a Pediatric Intervention[1]

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Background. **Pediatric well-care visits provide a clinical opportunity to counsel new mothers about their smoking and the deleterious effects of environmental tobacco smoke (ETS) on infant health.**

Methods. **Forty-nine Oregon pediatric offices enrolled 2,901 women who were currently smoking or had quit for pregnancy, using a brief survey at the newborn's first office visit. Randomly assigned offices provided advice and materials to mothers at each well-care visit during the first 6 months postpartum to promote quitting or relapse prevention.**

Results. **The intervention reduced smoking (5.9% vs 2.7%) and relapse (55% vs 45%) at 6-month follow-up, but logistic regression analysis at 12 months revealed no significant treatment effect. The intervention had a positive effect on secondary outcome variables, such as readiness to quit and attitude toward and knowledge of ETS. Multiple logistic regression analysis indicated that husband/partner smoking was the strongest predictor of maternal quitting or relapse.**

Conclusions. **A pediatric office-based intervention can significantly affect smoking and relapse prevention for mothers of newborns, but the effect decreases with time. Consistent prompting of the provider to give brief advice and materials at well-care visits could provide a low-cost intervention to reduce infant ETS exposure.**

Key Words: **smoking; cessation; relapse prevention; pediatricians; postpartum; environmental tobacco smoke.**

INTRODUCTION

Maternal cigarette smoking, both during pregnancy and postpartum, has serious deleterious health effects on the fetus and newborn infant [*1–3*]. The risks of smoking while pregnant have been known for several decades [*4*]. A large body of epidemiological data has also accrued that documents the risks of exposure to environmental tobacco smoke (ETS) for infants and young children [*5,6*]. Such risks include increased rates of upper and lower respiratory infections, otitis media, and asthma [*6*]. Maternal smoking is usually the primary source of ETS exposure for young infants [*7,8*].

National surveys estimate that approximately 30% of women are smokers when they become pregnant, with these rates varying by age, socioeconomic status, and ethnicity of the mother [*9,3*]. Despite publicized risks to the fetus, only 20 to 40% of women quit smoking when they learn they are pregnant [*10–12,3*]. An additional 3–16% may quit later in pregnancy [*10*]. Quitting smoking while pregnant appears to be associated with higher levels of educational attainment and socioeconomic status relative to nonquitters [*13*]. As we described elsewhere, 35% of the women in our sample reported quitting smoking for pregnancy, and factors related to their quitting were younger age, higher level of education, lower smoking level, having a partner who did not smoke, and not consuming alcohol [*14*].

Brief interventions by health-care providers in the context of medical care have been used to encourage pregnant women to quit smoking [*15*]. A recent meta-analysis of randomized trials of prenatal smoking cessation concluded that interventions resulted in a 50% increase in smoking cessation [*16*] and that more intensive counseling, use of multiple contacts, and supportive materials and follow-up result in a larger cessation effect [*16*].

Unfortunately, women who quit smoking for pregnancy are highly likely to relapse postpartum. An estimated 70–80% of women who quit during pregnancy relapse within a year of the birth of their child [*12*]. Few studies have examined postpartum relapse patterns or attempted to reduce relapse for mothers of newborns [*3,17*].

Public health officials have suggested encouraging and assisting parents in smoking cessation and relapse avoidance as an appropriate role for pediatricians [*18*].

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Regularly scheduled pediatric well-care visits offer a unique opportunity to relate parental smoking to the infant's health. Because mothers are seeking advice from the pediatrician on caring for and protecting their babies, they may be receptive to advice on the need to quit or not resume smoking and to protect their infants from exposure to environmental tobacco smoke. Pediatricians can provide such advice, while presenting information about the effects of environmental tobacco smoke, which may not be known by parents. Repeated well-care office visits offer a further opportunity to reinforce the no-smoking message with parents.

Statewide surveys of pediatricians in Maine and Vermont have assessed attitudes and practices of pediatricians concerning the provision of smoking cessation and relapse prevention advice to parents of patients [*19*]. The majority report advising parents to quit smoking (75%); however, only 40% took a smoking history and only 11% recorded the parents' smoking status on the child's chart [*19*]. Major barriers to providing smoking cessation advice included lack of time, lack of confidence, and perceived lack of support in the community. This is consistent with other surveys of physicians [*15*]. Only 8.5% of pediatricians had received any training in smoking cessation methods, but 87% said they were willing to learn those methods.

The Modification of Maternal Smoking (MOMS) study provided pediatricians and their staff with training and materials to advise mothers of newborns about smoking cessation and relapse prevention. The study enrolled 2,901 mothers of newborns, 1,583 of whom received the intervention during one or more of the four regularly scheduled well-baby visits over the first 6 months postpartum. At 6 months postpartum, the intervention had had a modest but significant effect on maternal smoking rates and a stronger effect on preventing relapse among former smokers [*20*]. The brief intervention also produced changes in mothers' attitudes and knowledge regarding ETS effects and less tolerance for allowing smoking in their homes. Since the intervention took place over the first 6 months postpartum, it is of interest to examine the longer-term durability of these effects. We report data from a 12-month follow-up of women enrolled in the study and evaluate the intervention relative to measures of office adherence to the protocol. This study also evaluates patient variables such as age, education, ethnicity, partner smoking, weight gain, parity, breast-feeding, and readiness to quit [*21*] as predictors of quitting or relapse at 1 year postpartum.

METHODS

Design

Pediatric practices were blocked and then randomized to Minimal (23 practices) or Extended (26 practices) intervention. Blocking variables were location (Portland metropolitan area versus other) and number of practitioners (1, 2–4, ⩾5]. Mothers of newborns attending these practices were the subjects, and mothers were the unit of statistical analysis after adjusting for practice-level effects.

Practitioner Recruitment

Members of the Oregon Academy of Pediatrics in the Portland area and the Interstate 5 corridor ($N = 158$) were invited by mail and telephone to participate. Of those invited, 128 pediatricians from 49 practices agreed to participate. Pediatricians had a mean age of 43.0 years, with a range from 29 to 64. There were no differences between conditions in age of pediatricians. Eighteen nurse practitioners and two physician assistants were included in the participating practices.

Enrollment

Study enrollment occurred at the first visit to the pediatrician's office in either condition, typically at 2 weeks postpartum. At this visit, mothers filled out a health questionnaire. If they answered yes to the question, "Did you smoke in the month prior to becoming pregnant?" they were included in the study. Subsequent questionnaire items allowed a breakdown of these mothers into Smokers (currently smoking) and Quitters (currently not smoking). A total of 13,495 surveys were completed by mothers of newborns, representing 76% of all mothers of newborns who came to the offices. Of 3,204 mothers reporting smoking prior to pregnancy, 2,901 forms were complete enough to allow follow-up. Figure 1 shows a breakdown of the number of Smokers and Quitters by study condition. A more extensive description of the study design and enrollment procedures appears in a previous paper [*20*].

Minimal and Extended Interventions

The intervention in both the Minimal and the Extended conditions began at the pediatrician's hospital visit after delivery (see Fig. 1), where all mothers (regardless of smoking status) received a packet of materials containing a brochure, a letter to the mother signed by her pediatrician, and a nursery sign. The message and materials were designed to alert the mother to reduce her newborn's exposure to passive smoke and also encouraged the mother to quit smoking or to stay quit if she had stopped for pregnancy. This hospital visit intervention constituted the Minimal condition.

The Extended condition delivered additional intervention at the first four well-baby visits, which generally occurred at 2 to 3 weeks, 2 months, 4 months, and 6 months after birth. Eligible mothers were categorized

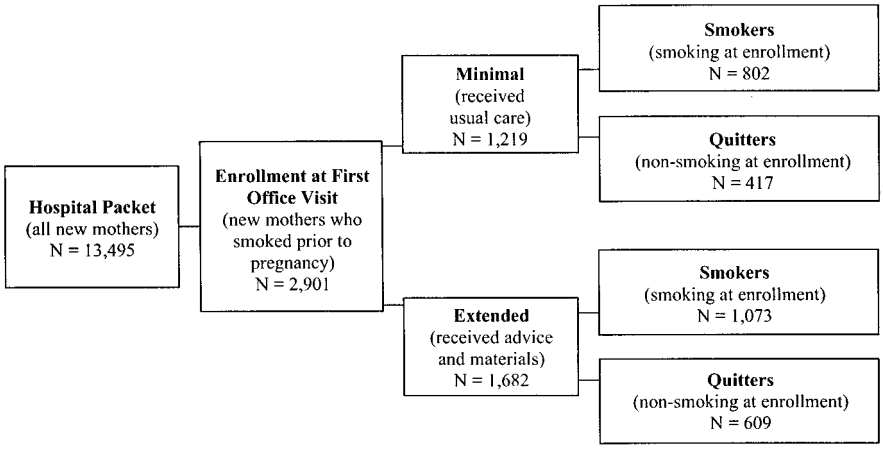

FIG. 1. Subject distribution by condition and smoking status.

as either a "Smoker," reporting current use of cigarettes, or a "Quitter," not currently smoking, but having smoked in the month prior to pregnancy. Babies' charts were tagged with a label denoting the mother's smoking status. An additional visual prompt was affixed to the chart for each visit (usually a newborn checklist sheet) that prompted the provider to follow the intervention protocol. Written project materials, tailored to the mother's current smoking status, were inserted into the chart by either a receptionist or a nurse. The intervention protocol comprised brief advice and encouragement at each visit, accompanied by specially developed written materials. A specially developed video was also to be shown at one of the visits. More detail on the intervention is presented in Wall et al. [*20*].

Physician and Staff Training

After practice randomization, a senior member of the research team met with pediatricians, nurse practitioners, and physician assistants in the Extended condition for a 45- to 60-min training session. They were given sets of written materials that provided guidelines for giving information, advice, and support and also contained a summary of the effects of passive smoking on infant health and development. Separate meetings were held with office staff to further delineate the practical aspects of study implementation, particularly enrollment of mothers in the study and minimization of any potential disruptions in office flow. Research staff visited the offices frequently before and just after start-up to support the staff and for problem solving, and then visited offices in both conditions at 2-week intervals to collect study forms and to discuss any practical obstacles to implementation.

Follow-Up Assessment

Outcome data were obtained from 6- and 12-month follow-up questionnaires mailed to all participants. Questionnaires were accompanied by a $2 bill as an incentive for returning forms, and cover letter stating that respondents would be entered in a monthly lottery with a chance to win $100.00. Subjects not returning questionnaires were mailed a second questionnaire 2 weeks after the first mailing; those not responding to the second mailing were then telephoned and the questionnaire was administered.

Measures

Outcome measures. Mothers were considered to be sustained quitters if they reported that they "had not smoked at all, not even a puff" for the past 7 days at both the 6- and the 12-month assessments. For current smokers, the extent of smoking was estimated using the midpoint of a categorical variable of cigarettes smoked per day: 1–4, 5–10, 11–20, >20. Measures of mother's knowledge of the health effects of passive smoking (7 items, Cronbach's $\alpha = 0.65$) and attitudes toward ETS (4 items, $\alpha = 0.66$) were also obtained, but only from those who completed the written questionnaires.

Predictor measures. Prospective predictor variables were obtained at baseline by means of a brief questionnaire given at enrollment. Predictor information included birth date, ethnic/racial background, education, the number of alcohol drinks in the past week, current and recent smoking status, the number of children, the number of smokers in the home, and whether smoking was allowed in the home. A variable assessing addiction for current smokers was created by standardizing and summing the amount currently smoked and time of first daily cigarette. Quitters were asked how confident they were that they could stay quit, while current smokers were asked how much they smoked and to indicate their interest in quitting by means of a contemplation ladder [*21*], an 11-item scale ranging from no thought of quitting (0) to taking action to quit

smoking (10). This measure also served as a secondary outcome measure to gauge the impact of the intervention on readiness to quit.

A number of concurrent predictors were assessed at the 6- and 12-month follow-up: partner's and other household members' smoking (as reported by the mother), alcohol consumption, breast-feeding practices, weight gain or loss, and infant illness history. Partners were considered current smokers if the mother checked "He smokes regularly" or "He smokes but avoids or has cut down the amount he smokes around the baby." Partners were considered nonsmokers if mothers indicated that "He quit smoking and continues not to smoke" or "He has never smoked." Mothers' reports of the receipt of intervention components (written materials, verbal advice, video) were also used as predictors.

Provider protocol adherence. Provider adherence to protocol was estimated in two ways: telephone surveys of mothers in both conditions to assess reported receipt of intervention components and chart reviews in the Extensive intervention condition to determine if the requisite labels and checklists were in place.

Telephone survey. A telephone survey of a randomly chosen 15% of mothers was performed 1 to 2 weeks after both the 2- and the 4-month well-care visits. Questions from these surveys were directed at obtaining a recalled estimate of physician/office compliance with the protocol. Mothers were asked whether they had received written materials or oral advice or had seen the project video at the last clinic visit. Similar questions were also included on the 6-month follow-up questionnaire. These data were collected from mothers in both conditions.

Chart reviews. The protocol required that mothers who reported smoking prior to pregnancy be identified and a label affixed to the baby's chart indicating whether the mother was a current "Smoker" or a "Quitter" (i.e., had quit for pregnancy). A checklist was then to be affixed to each chart prior to each visit, and the provider was to circle items on the checklist to indicate whether particular protocol events were delivered or had occurred. To ascertain how well this procedure was adhered to, within the constraints of practice confidentiality, we hired one person within each intervention practice to conduct a chart review. Project staff trained the designated chart reviewer and provided feedback on the first two charts. The charting was done anonymously with respect to both patients and individual providers, but the practice was identified. This procedure yielded several scores for each practice: presence of a Smoker or Quitter label on the chart; the percentage of checklists affixed for actual visits, and, for visits with checklists, the percentage marked by the provider as indicating that some intervention event had occurred. These data were obtained only from Extended intervention practices.

RESULTS

Attrition Analyses

Most analyses presented in this paper are based on the responses from 2,003 of the 2,901 mothers enrolled in the study (69.0%). These mothers completed both the 6- and the 12-month assessments. Of the 898 mothers who did not complete both assessments, 12 had babies who had died, 4 no longer lived with their babies, 44 refused to complete the 6- or 12-month assessments, and 838 could not be located for one or both assessments.

The proportions of mothers in the Extended (69.1%) and Minimal (68.9%) conditions who completed both assessments were similar. A significantly higher proportion of Quitters at enrollment (74.9%) than Smokers at enrollment (65.9%) completed both the 6- and the 12-month surveys [χ^2 (N = 2901) = 25.06; P < 0.001]. Mothers who completed both assessments were older [mean age 26.12 versus 23.99; t(2821) = −9.30; P < 0.001], more likely to have graduated from high school [78.0% versus 62.7%; χ^2 (N = 2719) = 86.22; P < 0.001], more likely to be Caucasian [87.4% versus 82.1%; χ^2 (N = 2624) = 12.72; P < 0.001], more likely to have more than one child [52.2% versus 26.26%; χ^2 (N = 2901) = 164.2; P < 0.001], and less likely to have husbands who smoked [51.7% versus 58.9%; χ^2 (N = 2901) = 13.07; P < 0.001]. There were no attrition differences on amount smoked prior to pregnancy, amount smoked at enrollment, or mother's drinking in the past week.

Comparison of Mothers in the Minimal and Extended Conditions

Mothers in the Extended condition who completed both the 6- and the 12-month assessments were older (mean age 26.4 versus 25.8; t(1946) = 2.39; P < 0.05), better educated (χ^2 (N = 1,884) = 15.37; P < 0.01), and less likely to have husbands/partners who smoked (49% versus 55.5%; χ^2 (N = 2241) = 7.67; P < 0.01) than were mothers in the Minimal condition. There were no differences between conditions on number of previous children, ethnicity of the mother, mother's smoking status during pregnancy, amount smoked prior to pregnancy, mother's allowing smoking in the home, or mother's drinking alcohol in the past week. For Smokers at enrollment, there were no differences between conditions on mother's level of tobacco addiction, amount smoked at enrollment, or contemplation to quit smoking; for Quitters at enrollment, there was no difference in confidence in remaining a nonsmoker. Since there were differences between conditions in age, education, and husband/partner's smoking status, sub-

sequent outcome analyses and analyses examining prediction of outcome controlled for these variables.

Practice effects. The unit of randomization for the study was the practice. However, since the unit of analysis was the mother, a mixed model analysis of variance with mothers nested within practices and practices nested within conditions (Minimal versus Extended) was used to examine the effect of the intervention. However, an analysis of quit rates by practice, for Smokers at enrollment, using this nested design was not possible since in some practices there were no mothers who quit smoking, resulting in zero variance within those practices. Since the intrapractice dependence, as measured by the intraclass correlations for initial smoking status, quitting for Smokers at enrollment, and relapsing for Quitters at enrollment, was low (0.002, 0.0009, and 0.013, respectively), this design effect was ignored for the analysis of quit rates. For the analyses of the effect of the intervention on other dependent variables, the practice effect was nonsignificant, with the intraclass (intrapractice) correlation ranging from 0.0002 to 0.025. Therefore, for purposes of simplification, the practice effect is not presented here.

Effect of the Extended Intervention on Smoking Cessation

The percentages in Table 1 assume that mothers who were enrolled in the study, but did not complete either the 6- or the 12-month assessment, were smokers at the time of assessment. The results show that among mothers who quit smoking for pregnancy, those who received the Extended intervention were significantly more likely to maintain their cessation throughout the 12-month period (N = 200/609; 32.8%) than were mothers who received the Minimal intervention (N = 109/417; 26.1%). Among mothers who smoked at enrollment, those who received the Extended intervention were significantly more likely to quit by the 6-month assessment, and stay quit throughout the 12-month assessment period (N = 25/1073; 2.3%), than were those mothers who received the Minimal intervention (N = 10/802; 1.2%). However, logistic regression, controlling for age, education, and husband/partner's smoking status at enrollment, indicated no effect of the intervention on sustained quitting for either Smokers (odds ratio 1.78, 95% CI 0.84, 3.74) or Quitters (odds ratio 1.25, 95% CI 0.93, 1.68) at enrollment.

TABLE 1

12-Month Quit Rates as a Function of the Intervention

	Minimal		Extended		
	N	%	*N*	%	χ^2
Continuous quit					
Quitters at enrollment	109/417	26.1	200/609	32.8	5.28*
Smokers at enrollment	10/802	1.2	25/1,073	2.3	2.94*
12-month quit					
Quitters at enrollment	163/417	39.1	261/609	42.9	1.45
Smokers at enrollment	38/802	4.7	59/1,073	5.5	0.54

Note. Results are based on a one-tailed test. Mothers who did not participate in one or both assessments were considered smokers.

* $P < 0.05$.

Effect on secondary outcome variables. Secondary outcomes were of interest since change in these outcomes may be related to the probability of future quit attempts for those mothers who did not quit smoking or who relapsed after quitting. Several univariate mixed-model analyses of covariance (with practice nested within condition), controlling for age, education, and husband smoking, as well as initial measures of the outcome variable, were used to examine differences between conditions on secondary outcomes. In all analyses the main effect of practice was not significant and thus is not reported here. Given that several of the outcome variables were correlated, and thus not independent, significance levels were adjusted, using a Bonferroni correction, to maintain an overall level of 0.05. Thus, for a single variable, an α of < 0.01 was considered significant.

Among mothers who were smokers at enrollment and continued to smoke throughout the 12-month period, mothers who participated in the Extended intervention smoked significantly fewer cigarettes per day; had a higher readiness to quit smoking, as measured by both the contemplation ladder and their self-reported likelihood of trying to quit smoking; had a more negative attitude toward smoking; and demonstrated more knowledge regarding the dangers of passive smoke exposure compared with mothers in the Minimal condition (see Table 2). Among mothers who had quit smoking at enrollment and subsequently relapsed, mothers who participated in the Extended intervention reported a significantly higher likelihood of trying to quit (again) than did mothers who participated in the Minimal condition. This effect was significant (F = 8.04; $P < 0.01$) even when controlling for the mother's education, age, and partner's smoking status at enrollment.

Predictors of Sustained Quitting

Potential predictors included characteristics of the pediatric practice (location [Portland versus outside of Portland] and practice size) and both prospective (variables measured at enrollment) and concurrent (variables measured at 6 and 12 months) predictors. The prospective predictors included characteristics of the mother's environment (parity of the newborn, the number of smokers in the house, and whether she allowed smoking in the home at enrollment), characteristics of the mother at enrollment (addiction to cigarettes, num-

TABLE 2

Effects of Intervention on Mothers Who Continue to Smoke (N = 1,200)

Variable	Adjusted means[a]		F
	Minimal	Extended	
No. cigarettes smoked per day[b]	12.88	11.65	8.78**
Readiness to quit smoking (contemplation ladder)[b]	5.95	6.49	16.49***
Likelihood of trying to quit smoking[b]	3.10	3.33	8.63**
Positive attitude toward smoking	8.88	8.25	9.43**
Knowledge about dangers of passive smoke exposure	4.64	5.09	17.12***

[a] Controlling for age, education, and husband's smoking status at enrollment.
[b] Controlling for variable at enrollment.
** $P < 0.01$.
*** $P < 0.001$.

ber of cigarettes smoked per day, intent to quit smoking as measured by the contemplation ladder, if she cut down during pregnancy, the amount smoked prior to pregnancy, abstinence from alcohol in the past week, and confidence in remaining a nonsmoker), advice/materials received from the pediatrician (receipt index: number of written materials received, number of times verbal advice received, whether or not she watched a video, and whether or not she received a teddy bear packet in the hospital), and the health of the infant during the first 6 months (number of emergency room and physician visits for acute illness, number of visits for respiratory illness, number of coughs, colds, etc.). Concurrent predictors included characteristics of the mothers' environment at 6 months (smoking status of the husband/partner, number of smokers in the home, and whether or not she forbids smoking in the home), smoking status of the husband/partner at 12 months, characteristics of the mother at 6 months (abstinence from alcohol in the past week, if she was currently nursing the baby, and weight gain/loss), and weight gain/loss at 12 months.

Separate univariate analyses predicting quit were performed for Smokers and Quitters at enrollment in each intervention condition. Significant univariate predictors within either condition were then selected for entry into a hierarchial forward multiple regression to determine which combination of variables best predicted sustained quitting. Condition, education, age, and partner's smoking status at enrollment were entered into the regression equation first, followed by practice variables, prospective predictors (measured at enrollment), and finally concurrent predictors (measured at 6 and 12 months). The amount of variance explained by each pair of variables, comprising the significant univariate predictor and its interaction with condition, was evaluated. Within each hierarchial cluster, the pair of variables that contributed the most variance was entered first. If the interaction was not significant, it was then dropped from the equation, and remaining pairs of variables were evaluated for entry, with the pair explaining the most variance entered next.

Smokers at enrollment. Controlling for age, education, and partner's smoking status at enrollment, significant univariate predictors of sustained quitting for Smokers at enrollment within each condition were partner's smoking status at both 6 months (Minimal: odds ratio 9.79; 95% CI 0.67, 57.55; $P < 0.01$; Extended: 8.67, 95% CI 2.89, 26.01; $P < 0.01$) and 12 months (Minimal: odds ratio 7.34; 95% CI 1.28, 42.02; $P < 0.01$; Extended: odds ratio 8.20; CI 2.70, 24.95; $P < 0.01$). Additional univariate predictors of sustained quitting for Smokers at enrollment within the Extended condition were forbidding smoking in the home (odds ratio 9.92; CI 2.91, 33.74; $P < 0.01$) and weight loss (odds ratio 1.24; CI 1.05, 1.47; $P < 0.05$).

The results of the hierarchial logistic regression are given in Table 3. No interactions with condition were significant, and, therefore, these interactions were dropped from the analysis. As Table 3 indicates, sustained quitting for Smokers at enrollment was best predicted by partner's smoking status at each time period and by forbidding smoking in the home. Thus, these results suggest that smoking mothers at enrollment were more likely to quit and stay quit if (a) their

TABLE 3

Results of Multivariate Logistic Regression Predicting Continuous Quit for Smokers at Enrollment

Variable	β	Odds ratio	Confidence interval
Condition	0.55	1.73	(0.76, 3.97)
Age	−0.01	0.99 (1.01)	(0.95, 1.09)
Education	−0.09	0.92 (1.09)	(0.71, 1.67)
Partner a nonsmoker at enrollment	1.35	3.87**	(1.60, 9.36)
Partner a nonsmoker at 6 months	−1.40	4.06*	(1.28, 12.90)
Forbid smoking in the home at 6 months	1.72	5.61***	(2.24, 14.04)
Partner a nonsmoker at 12 months	−1.85	6.39**	(1,95, 20.98)
Weight loss at 12 months	−0.20	1.22*	(1.05, 1.42)

Notes. Only significant univariate predictors were considered for entry.
* $P < 0.05$.
** $P < 0.01$.
*** $P < 0.001$.

partner was a nonsmoker at enrollment, (b) their partner either quit smoking between enrollment and 6 months or remained a nonsmoker at 6 months, or (c) their partner quit smoking between 6 and 12 months or remained a nonsmoker at 12 months. Mothers who reported that they forbid smoking in the home at the 6-month assessment were also more likely to maintain their cessation. Concern over weight loss appears to be significantly related to cessation, as those who quit smoking and stayed quit lost significantly less weight after the birth of their child than did those who continued to smoke.

Quitters at enrollment. Significant predictors of maintaining cessation for Quitters at enrollment in either condition were confidence in remaining a nonsmoker (Minimal: odds ratio 1.62; CI 1.15, 2.27; $P < 0.01$; Extended: odds ratio 1.66, 95% CI 1.30, 2.11; $P < 0.01$), forbidding smoking in the house (Minimal: odds ratio 1.95; 95% CI 1.05, 3.62; $P < 0.05$; Extended: odds ratio 1.85; 95% CI 1.11, 3.11; $P < 0.01$) , and abstinence from alcohol in the past week at the 6-month assessment (Minimal: odds ratio 1.81; 95% CI 1.01, 3.25; $P < 0.05$; Extended: odds ratio 1.71; 95% CI 1.14, 2.57; $P < 0.01$). For Quitters at enrollment in the Minimal condition, additional significant predictors were abstinence from alcohol in the past week at enrollment (odds ratio 2.09; 95% CI 1.04, 4.20; $P < 0.05$) and number of medical visits for respiratory illness (odds ratio 1.89; CI 1.13, 3.17; $P < 0.05$). For Quitters at enrollment in the Extended condition, additional significant predictors were partner a nonsmoker at both 6 months (odds ratio 2.70; CI 1.51, 4.82; $P < 0.01$) and 12 months (odds ratio 3.27; CI 1.87, 5.73; $P < 0.01$), number of smokers in the home at 6 months (odds ratio 2.58; CI 1.51, 4.42; $P < 0.01$), and weight loss (odds ratio 1.18; CI 1.06, 1.32; $P < 0.01$).

In the hierarchial logistic regression, the significant predictors of relapse (Table 4) were husband's smoking status at enrollment, change in husband's smoking status by 12 months, confidence in remaining a nonsmoker at enrollment, consumption of alcohol at 6 months, and the interaction of weight loss with condition. Interpretation of this interaction suggested that for mothers in the Extended condition, those who relapsed lost more weight since the birth of their child than did those who maintained their cessation. Although weight gain/loss was included as a predictor because it was expected that those who were having difficulty returning to their prepregnancy weight would be more likely to relapse, weight loss did not appear to predict relapse in the expected direction.

Because it was such a powerful predictor, the relation between the mother's maintenance and relapse and husband's smoking status and changes in status was further analyzed. Of those women who were Smokers at enrollment, but quit and remained quit through the 12-month assessment ($N = 35$), none had a husband who started smoking between enrollment and 6 months, and 28.6% had husbands who quit and remained quit. In contrast, among those women who smoked throughout the 12-month period ($N = 1{,}745$), 5.9% had husbands who started smoking between enrollment and 6 months, and 7.8% had husbands who quit smoking between enrollment and 6 months. Similar patterns are evident for relapse. Among those mothers who quit at enrollment and relapsed by either 6 or 12 months ($N = 717$), 11.7% had husbands who started smoking between enrollment and 6 months, and an additional 9.1% had husbands who started smoking between the 6- and the 12-month assessment. In contrast, only 5.5% of mothers who maintained their cessation through the 12-month assessment ($N = 309$) had husbands who started smoking between enrollment and the 6-month assessment, and 2.9% had hus-

TABLE 4

Results of Multivariate Logistic Regression Predicting Continuous Quit for Quitters at Enrollment

Variable	β	Odds ratio	Confidence interval
Condition	0.134	1.14	(0.80, 1.63)
Age	0.035	1.04*	(1.00, 1.07)
Education	0.017	1.02	(0.85, 1.22)
Partner a nonsmoker at enrollment	0.53	1.70*	(1.00, 2.87)
Confidence in remaining a nonsmoker	0.47	1.60**	(1.30, 1.96)
Partner a nonsmoker at 6 months	−0.35	1.42	(0.82, 2.44)
Forbid smoking in home at 6 months	0.56	1.75*	(1.15, 2.67)
Abstained from alcohol in the past week at 6 months	−0.51	1.66**	(1.16, 2.38)
Weight loss at 6 months	0.09	1.09*	(1.00, 1.20)
Weight loss by condition at 6 months	0.22	1.25*	(1.05, 1.48)
Partner a nonsmoker at 12 months	−0.86	2.35**	(1.40, 3.97)

Notes. Only significant univariate predictors were considered for entry.

* $P < 0.05$.

** $P < 0.01$.

bands who started smoking between the 6- and the 12-month assessments.

Reported Receipt of Intervention

The results of the 2- and 4-month phone probes have been reported previously [*20*]. Briefly, data from both time periods showed that mothers in the Extended condition reported receiving significantly and substantially more advice than did mothers in the Minimal condition. For example, there were twofold differences in reported advice to quit (68% versus 27% at 2 months; 59% versus 33% at 4 months).

Practice Adherence

Chart review data revealed considerable variability in protocol implementation across practices. The presence of a MOMS label on a subject's chart ranged from 24 to 94%, with a median of 69%. We also looked for the presence of "checklists," which served to prompt provider interventions, for patients by visit (patients frequently did not attend all four well-care visits). These data showed that the implementation of the MOMS protocol decayed across time. For visits 1 through 4, the median percentage of checklists on charts was 61, 50, 32, and 24%. The relationship between office adherence to the protocol and study outcome was assessed by correlating two measures of practice adherence with both quitting and relapse. When analyzed by practice, the relationship between the number of MD checklists and percentage of enrolled mothers with an identification sticker on the outside of the chart were correlated with both percentage of Quitters who did not relapse and percentage of Smokers who quit. Neither of these factors were significantly related to study outcome ($r =$ 0.34 and 0.25, respectively, for relapse, and 0.34 and 0.13 for quitting). When MD checklists were present in the chart, 85% of these checklists showed one or more intervention activities checked.

Cost Data

Cost data had been gathered with the intention of performing a cost-effectiveness analysis for the intervention. We concluded that such an analysis was not justifiable, given the small and marginally nonsignificant intervention effect on cessation at 12 months. However, the significant effect of reduced parental smoking and the 6-month cessation and relapse prevention outcomes [*20*] may have provided some benefit to the infants. Additionally, we observed significant changes in knowledge of ETS, reduced ETS exposure, and increased readiness to quit. Therefore, our cost data may be useful in assessing the value of replicating the intervention.

Costs would include training time, the time involved for staff assessment and advice/counseling, and materials. We estimate that for a practice with up to four pediatricians and six office staff, one-time costs to begin implementing the MOMS intervention should be under $500 (with up to $200 budgeted for an outside facilitator). Staff costs to determine and record the smoking status of each new mother entering the practice would be approximately 20–75¢ per mother. Intervention costs (professional time, staff time, and written materials) for Smokers and Quitters would total $10 to $15 per mother over four visits, with up to $10 more for smoking mothers needing assistance with a quit attempt. (More detailed cost information is available from the corresponding author.)

DISCUSSION

The results of this pediatric office-based intervention moderately support the value of having pediatricians and their nursing staff provide smoking cessation advice and materials to new mothers who are currently smoking or who quit for pregnancy. Pediatricians in private practice can have a significant impact on maternal smoking, as evidenced by the results of a 6-month follow-up, but this effect was reduced over time. While the MOMS intervention was marginally effective at the 12-month follow-up, using univariate analysis, a logistic regression analysis was not significant, suggesting that these differences were due to initial differences between groups. However, even when controlling for initial group differences, there was a significant effect for the program at 6 months. This conservative analysis was not reported by Wall et al. [*20*] in our previous publication.

The quit rates for 6- and 12-month follow-up are modest. Using a conservative intent-to-treat model, we counted all mothers lost to follow-up (not completing either the 6- or the 12-month follow-up) as Smokers, but the intervention, while significant at 6-month follow-up, was not significant at 12 months for continuous quit (both 6 and 12 month) for mothers who completed both assessments. This sustained quitting is a stringent endpoint criterion and typically results in lower quit rates than point prevalence estimates [*22*,*23*].

The appearance of a program effect at the 6-month follow-up that reduced to nonsignificance at 12 months is of concern and may be due to an increase in quit rates from 6 to 12 months for mothers in Minimal practices. While the quit rates for mothers who smoked at enrollment in Extended offices was twice that of Minimal offices at 6 months (5.9% versus 2.7%), this difference had declined to 5.5% versus 4.7% at 12 months. The increased quitting in Minimal offices may have been due to increased anti-smoking activity by some pediatricians. Minimal offices were continually reminded of being in the intervention, as they provided an informational packet to new mothers in the hospital visit and their offices were visited weekly by our staff to

pick up enrollment forms. Moreover, during this period, the media and the profession increased their attention to the issue of ETS (i.e., articles on the relationship of SIDS and ETS). These factors could have made this issue more salient to Minimal intervention pediatricians and prompted more office activity on this issue. There were some reports from Minimal offices who were anxious to get project materials to provide to mothers. The effect of the program on quitters also eroded between the 6- and the 12-month assessments, and what had been a relapse prevention effect at 6 months was no longer significant. It appears that without prompting there is a continuing relapse for women who quit smoking for pregnancy.

Women who continued to smoke through pregnancy, despite possible advice from their obstetrician, or who had relapsed by the first pediatric well-care visit 2 weeks postpartum, may be a difficult group to target for cessation. These Smokers represent a group for which minimal advice and materials provided by the pediatrician may not be of sufficient intensity or magnitude to impact their smoking behavior. The best predictors for whether a mother would quit smoking at 6 and 12 months postpartum were whether she allowed smoking in her home and whether her husband/partner smoked. It is interesting that the strongest predictor of quitting was the mothers' report of not allowing smoking in the home at 6 months. The program and materials emphasized the detrimental effects of ETS on the babies' health, and mothers were told to avoid exposing their child to ETS if possible. Many mothers reported that they were more comfortable in getting themselves and others to smoke outside than to quit smoking. This intermediate step of making the house smoke-free is probably an important step toward quitting and could be characterized as a stage of change. Future programs may want to emphasize the prohibition of smoking in the house for women not willing or ready to quit smoking. This is consistent with focus group feedback, in which mothers reported that ETS health effects were new information, and they felt more comfortable in restricting household smoking than in quitting.

For women who have quit smoking for pregnancy, the postpartum relapse rate is high, but consistent with the literature. Recent studies report estimates ranging from 40 to 90% of these women returning to smoking within the first 6 months postpartum [*1*,*12*,*17*]. These rates are surprisingly high, since most smoking cessation during pregnancy occurs in the first trimester and by delivery the mother has been abstinent for 6 months or longer [*10*]. It appears that for many women, the context of pregnancy is a time-limited and clearly defined event during which tobacco abstinence may be more easily maintained and that the stress of the transition to parenthood can contribute to relapse [*24*]. A focus on relapse prevention with new mothers is critical both to maintaining abstinence that now has been established and to reducing infant exposure to the risk of ETS.

The best predictors of whether a woman who quit smoking for pregnancy would remain a nonsmoker were confidence in remaining a nonsmoker, husband's smoking status, consumption of alcoholic beverages at 6 months, and weight loss at 6 months. The husband's smoking status is a major factor in a woman's relapse, as it is probably difficult to remain a nonsmoker when living with a partner who continues to smoke or relapses. This factor probably also influences the mother's report of confidence in remaining a nonsmoker. Alcohol consumption has been cited by authors as a high-risk situation for relapse [*25*], which is confirmed here, with alcohol use at 6 months being predictive of subsequent relapse.

The concern for weight gain or loss with continued smoking cessation is an issue that has received increasing attention [*26–28*]. In this study, it appears that women who lost more weight were more likely to have relapsed, which is consistent with the use of cigarettes as a part of an effort to lose weight gained during pregnancy. These women may be most concerned with returning to their prepregnancy weight and thus more likely to use cigarettes. This is consistent with other studies that report concern about weight gain as a significant predictor of relapse at 6 months postpartum [*17*]. Future programs with postpartum women will need more emphasis on this issue in the materials and counseling provided.

The husband's smoking status was predictive for each assessment point (enrollment, 6 months, and 12 months), but decreased in significance with time. The strong association of the husband's smoking status with subsequent quitting indicates the critical nature of this relationship in any attempt to reduce women's smoking. The MOMS program had little contact with fathers, as they were not usually present at well-care visits, and print materials were aimed at encouraging the mothers to quit. One deficiency of a pediatric office intervention is the inaccessibility of fathers and lack of materials specifically for fathers. Some creative efforts have used videos, newsletters, and mailings directed at fathers [*29*], and this outreach should be a part of any comprehensive effort to affect maternal smoking. The MOMS project sent one letter to fathers, but there was no evaluation of whether fathers read or were affected by it. Future programs should make a concerted effort to impact the fathers and evaluate their receipt of materials.

While smoking cessation or nonsmoking was the primary endpoint of the study, we were also interested in examining variables that may be related to changes in related behaviors. It was encouraging to observe that mothers exposed to the intervention smoked significantly fewer cigarettes per day, were more knowledge-

able about ETS, had more negative attitudes toward smoking, and reported a higher stage of readiness to quit smoking at 12 months than mothers in the Minimal condition. Extended intervention mothers also reported more negative attitudes toward ETS exposure, more knowledge about deleterious effects of ETS, and more quit attempts. These mothers have been impacted by the program even if they did not meet the criterion of quitting. Prochaska et al. [*30*] have described the tobacco cessation process as one of moving through stages of readiness, and the behaviors reported by the mothers receiving the intervention indicate an increased likelihood of readiness to quit smoking. Getting these women to make continued quit attempts can be beneficial, as it has been suggested that on average, a smoker reports multiple quit attempts before succeeding [*31*].

One concern with any medical office-based intervention that depends upon the commitment and goodwill of providers is the degree to which the practitioners actually implement the recommended procedures [*22*,*23*]. In the MOMS study, pediatricians, nurse practitioners, nurses, and front office staff all played roles: identifying mothers' smoking status, tagging the babies' charts with stickers and prompts, and subsequently giving mothers materials and advice to encourage tobacco abstinence. The brief intervention was designed to be flexible and adaptable to clinic practices and procedures, but still involved a change in routine. There were many potential obstacles to the program's full implementation, as these were busy pediatric clinics with frequent time pressures.

We measured the practice compliance with the protocol in various ways, but the most useful and compelling were chart reviews. Review of charts showed a decline in protocol adherence with successive visits. The offices were best at carrying out recommended procedures for the first visit (61% of the time); each subsequent visit (2-, 4-, and 6-month visits) showed a decline in the percentage of mothers whose babies' charts were tagged to prompt intervention. This steady decline in the percentage of mothers receiving the intervention suggests a need to prompt the providers. Previous studies have shown that repeated messages increase the effectiveness of smoking cessation with women [*10*], and well-care visits provide a regularly scheduled opportunity to provide support for tobacco abstinence. In the current study, when a sticker or prompt was in the chart, the provider usually offered advice and materials at the well-care visits. The problem in this study, and others that depend upon prompts for providers, is developing a system commitment to using stickers or prompts among the office staff. The decay in protocol adherence observed in this study may explain in part the decrease in cessation rates for Smokers and increased relapse observed with Quitters over time. Future programs are likely to achieve better outcomes if staff can be prompted to provide some brief advice and materials at each well-care visit. The prompts appear critical, as 85% of the time the staff noted some intervention activity if an MD checklist was put into the chart. Given that the MOMS label only appeared on 69% of the charts and MD checklists were also not consistently used, future studies should focus on ways to ensure that patient identification and provider prompt sheets appear on the chart. Our experience indicated that adoption of the program by all pediatricians and key staff is critical to full implementation. Other researchers have also reported that involvement and commitment by nurses and office personnel are critical to adherence to the protocol [*22*,*23*]. If the program was enthusiastically endorsed by the pediatricians, and nurses and front office staff participated in the adoption decision, we observed higher rates of protocol adherence.

Pediatric well-care visits offer a unique clinical opportunity to discuss the effects of tobacco smoking on infant development and health. The pediatrician or nurse can offer a cessation or relapse prevention message in the context of regular office visits, and this brief intervention may lead to reduced exposure of infants to ETS. While the long-term impact on maternal smoking was disappointing, there was evidence for reduced smoking, increased knowledge of ETS effects, and a higher stage of readiness to quit smoking on the part of the mothers. Previous research involving four home visits to smoking mothers has demonstrated that intensive interventions can significantly reduce infant passive smoking and lower respiratory illness [*32*]. However, the current brief in-office program was designed to be easily integrated into well-care visits and provide a low-intensity program that could be broadly adopted as a low-cost public health intervention. Future research should focus on ways to increase the consistency of program and advice implementation and more consistent implementation by office staff. Previous research has advocated using health care visits as opportune times to counsel adults to quit smoking, and this study uses the concern for ETS exposure to infants as a vehicle for extending this approach to pediatric offices.

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