
A Cost-Benefit Analysis of Smoking Cessation Programs During the First Trimester of Pregnancy for the Prevention of Low Birthweight

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Background. The frequency of low birthweight decreases when women quit smoking in the first trimester of pregnancy. This analysis examines the cost-effectiveness of smoking-cessation programs during pregnancy for the prevention of low birthweight.

Methods. Using data from the 1988 National Health Interview Survey and estimated costs of care for low birthweight and normal birthweight infants, a decision tree was constructed to estimate break-even costs for smoking-cessation programs, assuming a success rate of 18%. Sensitivity analyses were performed to determine how program effectiveness and changes in the population affected the break-even costs.

Results. For a population similar to that which participated in the 1988 National Health Interview Survey,

smoking-cessation programs would be cost-effective if the program cost \$80 or less. In general, to be cost-effective, a smoking-cessation program has to decrease smoking rates by 2.15% to justify every \$10 in program costs. Sensitivity analyses showed that as the baseline spontaneous quit rate in the smoking population decreases, smoking-cessation programs of higher cost become more cost-effective.

Conclusions. Smoking cessation programs during pregnancy may be cost-effective for preventing low birthweight if their cost is \$80 or less and they achieve success rates of at least 18%.

Key words. Smoking cessation; behavior therapy; infant, low birthweight; cost-benefit analysis.

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Cigarette smoking during pregnancy has been linked to several adverse outcomes.^{1,2} Included in the effects of cigarette smoking on pregnancy is the association between cigarette use and preterm or low birthweight infants. Since low birthweight and prematurity are the leading preventable contributors to morbidity and mortality in infancy,^{3,4} attention has been focused on the effects of cigarette use on low birthweight.⁵

As a means of addressing the problem of smoking during pregnancy, a number of smoking-cessation programs have been developed.⁶⁻⁹ Researchers have analyzed

the impact of these programs on low birthweight rates and have found that smoking-cessation programs can be cost-effective.^{8,10,11} However, these analyses assumed that smoking cessation early in pregnancy results in a complete reduction of low birthweight risk comparable to that of nonsmoking women. Evidence suggests that this assumption is not true. Smoking cessation appears to reduce the risk of low birthweight only if a woman stops smoking early in pregnancy.^{12,13} Additionally, even for women who discontinue smoking in the first trimester, the risk of giving birth to a low birthweight infant does not fall to the level of risk for women who never smoked, but rather remains slightly elevated.¹³

This study reexamines the issue of the cost-effectiveness of smoking-cessation programs for pregnant women, adjusting the expected benefits of smoking cessation in the following manner: (1) only women who present for care in the first trimester can expect a risk reduction with

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Table 1. Effect of the Spontaneous Smoking Cessation Rate on Break-even Costs of Programs with Differing Smoking-Cessation Effectiveness Rates

Baseline Quit Rate	Program Costs (\$) by Program Effectiveness Rate		
	3%	18%	29%
6%	21	124	201
15%	19	113	182
37%	14	84	135

*Maximum cost possible for program to be considered cost-effective. Note that the lower the baseline quit rate, the more a program can cost to achieve a given effectiveness rate.

imately 2.15% for every \$10 per participant spent for a smoking-cessation program.

Finally, we examined how the baseline rate of smoking cessation among smokers who presented in the first trimester affected the break-even costs. Using 6% as the minimal spontaneous smoking-cessation rate in the population and varying this estimate up to the 37% spontaneous quit rate used in the initial analysis, we found that as the baseline spontaneous smoking-cessation rate decreased, the break-even costs for programs of equal effectiveness increased (Table 1). The increase in the break-even cost is most noticeable with programs achieving higher effectiveness. Programs that are less effective in increasing the smoking-cessation rates among pregnant women had relatively little increase in the break-even point in their cost-benefit analysis.

Discussion

Our analysis of smoking-cessation programs in pregnancy shows that programs costing \$80 or less will be cost-effective when the impact of smoking cessation on the frequency of low birthweight is considered as the primary outcome. This cost value for the break-even point of smoking-cessation programs is considerably higher than what others have estimated.^{10,11} The primary reason for the higher break-even costs estimated in this study as compared with prior studies is the higher incidence of low birthweight seen in the infants of smokers in the 1988 National Health Interview Survey and a larger difference in low birthweight risks among smokers, quitters, and nonsmokers.¹³

This study also shows that the cost-to-benefit ratio of a smoking-cessation program is highly dependent on the effectiveness of the intervention and the percentage of women who will spontaneously quit without an intervention. For populations in which the spontaneous quit rate is fairly high, programs with minimal effectiveness, such as discussing smoking cessation during a routine office visit, must cost less than \$14 to be cost-effective. Intensive

Table 2. Estimated Costs of Smoking Cessation Interventions

Intervention	Estimated cost, (\$)
Brief advice during visit*	10
Acupuncture†	50
Organized support groups†	50-225
Nicotine gum†	100-600
Nicotine patches†	350

*Datum based on Cummings et al.¹⁵

†Adapted from Price tags: quitting smoking. *The New York Times* 1993 July 22; C:2.

programs that can achieve quit rates in the 25% to 30% range will be cost-effective only if they cost less than \$135. For populations in which the spontaneous quit rate is low, more expensive programs can be justified.

Estimates of the costs of various smoking-cessation interventions are shown in Table 2. Based on our analysis, many of these programs must be highly effective to justify their cost when the reduction in low birthweight costs is the desired outcome. However, in populations where few women spontaneously stop smoking early in their pregnancy, these programs may still be cost-effective even if they are not extremely efficacious.

While this analysis may be useful in estimating the cost-to-benefit ratio of smoking-cessation programs during pregnancy for the prevention of low birthweight, there are limitations to the analysis that need to be stressed. First, only a single outcome, ie, prevention of low birthweight and its associated costs, was considered. Smoking cessation may have other advantages during pregnancy. Increases in placental abnormalities,²¹ maternal hemorrhage,²² and preeclampsia²³ have been noted in smokers. However, the issue of causality for smoking and these other pregnancy outcomes is less clear. For example, there have been no data that demonstrate that these complications are reversible with the discontinuation of smoking during pregnancy. Based on the questionable causal link between smoking and less common outcomes, we chose not to include these in our analysis. Had we included these, the cost-effectiveness of smoking-cessation programs would have been increased, albeit only slightly, since these outcomes occur less frequently than low birthweight and are associated with a smaller additional cost.

Second, the costs and complication rates used for the study were averages and not adjusted for potential effect modifiers. Other variables related to the rate of low birthweight, such as socioeconomic status or race, could interact with cigarette smoking to influence the effects of smoking on birthweight. If further research identified populations in whom smoking has a greater adverse effect, greater benefit would be achieved at higher costs and the calculations in this study would need to be modified.

Additionally, this study focused only on the short-

term positive effect of smoking cessation on pregnancy outcomes. Long-term benefits of smoking cessation were not considered. In general, smoking-cessation advice, while minimally effective, has been identified as one of the most cost-effective preventive practices.¹⁶ Since the spontaneous quit rate during pregnancy is high,¹³ it is likely that pregnancy is a time when women may be particularly receptive to smoking-cessation interventions. Thus, by not considering the long-term benefits, this analysis may underestimate the true cost-effectiveness of smoking-cessation programs. However, the consideration of long-term benefits from smoking cessation during pregnancy is complicated by unknown rates of recidivism after birth.

Finally, our model is limited to smoking cessation achieved only in the first trimester. Since evidence suggests that smoking cessation during later stages of pregnancy is not as effective in reducing low birthweight rates,^{12,13} we believe that this model is most appropriate. However, should future evidence show that smoking cessation later in pregnancy reduces the frequency of low birthweight or that it results in similar rates of low birthweight infants who are less ill and whose care is therefore less costly, then re-analyses should be performed to determine cost-benefit levels for programs targeting women in the latter two trimesters of pregnancy.

Maternal cigarette smoking is a modifiable risk factor for low birthweight infants.^{1,13} Consequently, as with the results of all cost-benefit analyses, the practitioner must decide if the benefit-to-cost ratio is favorable for a particular program before implementing such a program. In this case, considering that the cost of having a low birthweight infant is high and that many risk factors for low birthweight, such as race¹⁹ and age,²⁰ are not modifiable, the benefit for implementing a smoking-cessation program in early pregnancy seems worthwhile if programs can demonstrate a reasonable effectiveness at increasing the rate of women who discontinue smoking early in pregnancy. Physicians should also be cautioned that up to one third of all pregnant smokers may stop smoking without any intervention. When evaluating smoking-cessation programs for pregnant women, physicians should focus on the increase over this baseline rate and not rely on the overall quit rate that is inflated by the high spontaneous quit rate.

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