Multilevel Intervention for Low-Income Maternal Smokers in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)

Bradley N. Collins, PhD, Stephen J. Lepore, PhD, and Brian L. Egleston, PhD

See also Meghea, p. 351.

Objectives. To test the efficacy of Babies Living Safe and Smokefree (BLiSS), a multilevel intervention initiated in a citywide safety net health system to improve low-income maternal smokers' abstinence and reduce child tobacco smoke exposure.

Methods. This randomized controlled trial in Philadelphia, Pennsylvania (2015–2020), recruited low-income maternal smokers who received a brief smoking intervention (Ask, Advise, Refer [AAR]) from nutrition professionals in the Special Supplemental Nutrition Program for Women, Infants, and Children before randomization to (1) a multilevel intervention (AAR + multimodal behavioral intervention [MBI]; n = 199) or (2) an attention control intervention (AAR + control; n = 197).

Results. AAR + MBI mothers had significantly higher 12-month bioverified abstinence rates than did AAR + control mothers (odds ratio [OR] = 9.55; 95% confidence interval [CI] = 1.54, 59.30; $P = .015$). There were significant effects of time (b = −0.15; SE = 0.04; $P < .001$) and condition by time (b = −0.19; SE = 0.06; $P < .001$) on reported child exposure favoring AAR + MBI, but no group difference in child cotinine. Presence of other residential smokers was related to higher exposure. Higher baseline nicotine dependence was related to higher child exposure and lower abstinence likelihood at follow-up.

Conclusions. The multilevel BLiSS intervention was acceptable and efficacious in a population that experiences elevated challenges with cessation.

Public Health Implications. BLiSS is a translatable intervention model that can successfully improve efforts to address the persistent tobacco-related burdens in low-income communities.

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Maternal smoking and child tobacco smoke exposure (TSE) remain leading causes of preventable disease and death.[1] In 2020, the World Health Organization estimated that tobacco kills more than 8 million people annually, including more than 1 million nonsmokers exposed to tobacco smoke.[2] Despite the decrease in global smoking prevalence since 2000, prevalence among females has decreased more slowly than prevalence among males, and an income disparity has emerged. Large disparities exist in the United States across disadvantaged groups,[1] with smoking prevalence in low-income groups nearly twice as high as prevalence in higher-income groups.[3] Similar TSE disparities exist, with younger children from disadvantaged households bearing the greatest burden.[4] Because of the serious consequences and growing disparities in maternal smoking and child TSE, effective

interventions are needed in underresourced communities to address this public health priority.[5]

Low-income smokers respond well to evidence-based interventions.[6] In practice, however, evidence-based interventions have limited reach to high-risk smokers, and poverty remains strongly linked to cessation challenges among maternal smokers.[7,8] Public health researchers and practitioners have long recognized the potential population impact of addressing tobacco disparities by partnering with safety net community health organizations, such as the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). To date, however, approaches in these settings have had limited effectiveness, as they tend to emphasize brief advice without the more intensive skills training necessary to promote smoking behavior change.[9,10] For example, standard WIC operations do not include routine tobacco screening and intervention, missing an opportunity to reach a high-risk population in which smoking rates exceed the general population. Also, systematic reviews of caregiver interventions designed to reduce child TSE and promote parental cessation reflect mixed results in trials to date as well as a void of multilevel interventions that could address a wider array of smoking determinants.[11–13]

The Babies Living Safe and Smokefree (BLiSS) trial addressed these shortcomings by testing a multilevel intervention that targeted multiple determinants of smoking behavior change across levels of influence. The first treatment element was a WIC system intervention, translated from the American Academy of Pediatrics best practice guidelines for tobacco intervention (i.e., Ask, Advise, Refer [AAR], also known as 2As + R).[14] Embedding it in routine client intake procedures, we designed this brief intervention to guide WIC nutrition counselors to encourage smokers to initiate behavior change and connect them to evidence-based resources. AAR was linked to a more intensive, multimodal behavioral intervention (MBI) grounded in telehealth counseling that was designed to address individual- and family-level determinants of cessation and child TSE. MBI elements included nicotine replacement and counseling integrated with a mobile app and multimedia health education and skills training materials. Thus, BLiSS provided multiple sources of health information, advice, support and skills training, and repeated doses of intervention across multiple modalities and levels of influence.

A behavioral ecological model[15] provided the conceptual framework. It suggests that systematic multilevel intervention elements delivered across levels of determinants can produce synergistic intervention effects that maximize the likelihood of behavior change. For example, integrated individual- and family-level counseling components could augment WIC system-level messaging advocating smokefree homes and children's TSE protection. The interacting effects of advice, messaging, support, and accountability across levels of influence could enhance smokers' effort to reduce TSE compared with a single-level approach alone.[16,17] We applied this logic in designing the multilevel BLiSS intervention (AAR + MBI). We hypothesized that integrating our WIC system-level intervention with the individual- and family-focused MBI elements would result in a more effective intervention would than AAR plus an attention control intervention (AAR + control) in reducing bioverified child TSE (primary outcome) and promoting bioverified maternal smoking abstinence.

METHODS

We used a parallel 2-group randomized controlled design with assessments at baseline, 3-month end of treatment, and 12-month follow-up. In the trial, we implemented brief tobacco intervention in 10 Philadelphia, Pennsylvania, WIC clinics. After AAR, we based randomization on a permuted blocks design with stratification by site and presence of other smokers in the home (yes/no). The design was guided by CONSORT (Consolidated Standards of Reporting Trials) criteria.[18] Eligible participants were English speaking, mothers or female guardians, smokers, and older than 17 years; owned a smartphone; and had a child younger than 6 years. Exclusion criteria included pregnancy and conditions that could interfere with the ability to provide informed consent or follow procedures (active psychosis, insufficient health literacy, and nonnicotine drug dependence). Figure 1 shows participant flow.

Procedures

Before enrolling participants, we conducted a formative analysis of WIC tobacco intervention practices to inform our translation of pediatric guidelines (AAR) to WIC operations. We conducted eligibility and baseline assessments via telephone and then performed randomization and in-home treatment orientation, during which we collected children's baseline urine sample (to test for cotinine, a TSE biomarker). Both groups received information about cessation resources, nicotine replacement therapy (NRT), condition-specific written

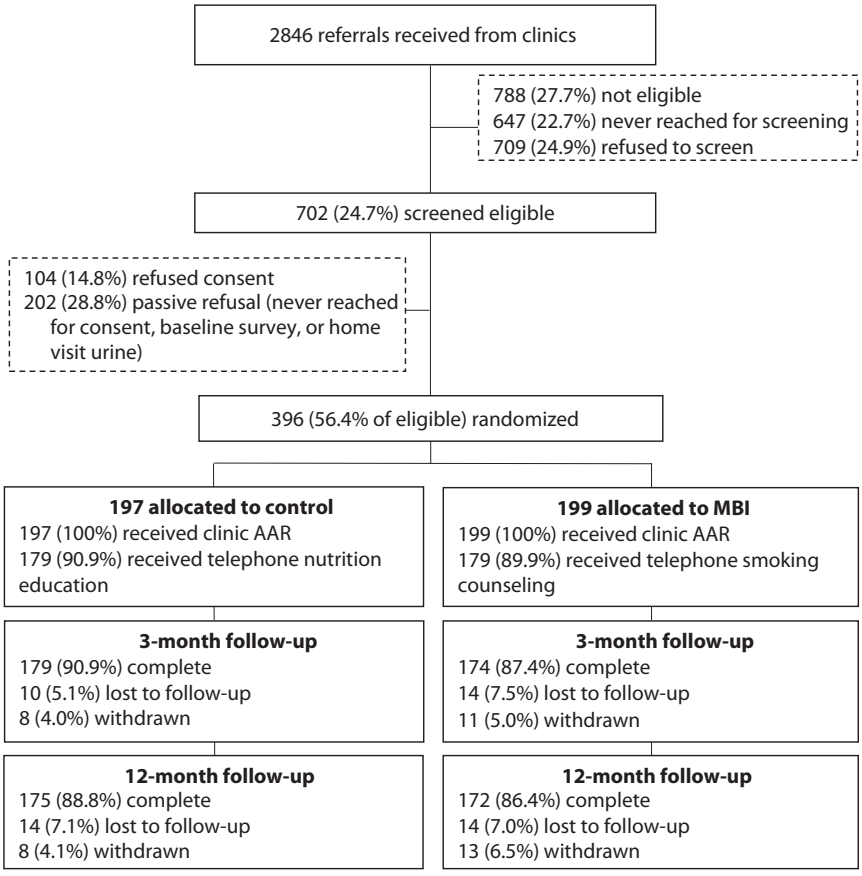

FIGURE 1— Trial Profile and Participant Flow: Babies Living Safe and Smokefree Trial; Philadelphia, PA; 2015–2020

Note. AAR = Ask, Advise, Refer; MBI = multimodal behavioral intervention.

materials, mobile app, and 12-weeks of telephone counseling. Blinded research staff conducted 3- and 12-month structured telephone assessments followed by home visits to obtain child urine cotinine and bioverify participants' reported abstinence (with saliva cotinine and expired carbon monoxide).

WIC system intervention (both groups). Nutrition professionals trained by investigators delivered AAR in routine paper-based client enrollment workflow. In the clinics, trial staff put up trial posters and set out pamphlets highlighting TSE dangers, benefits of smokefree homes and child TSE reduction, and AAR prompts to reflect smokefree norms in the WIC system and encourage WIC nutrition counselors' AAR delivery. During intake assessments, WIC counselors offered mothers information about TSE consequences and advice about TSE reduction and referral to the trial.

Attention control intervention (AAR + control). These participants received equivalent contact time as the AAR + MBI group that included AAR plus 12 weeks of nutrition counseling with parallel adjunctive treatment modalities. Intervention included up to 5 sessions with intersession texts; the Fooducate app; and a multimedia tool kit from Sesame Street Workshop called Food for Thought: Eating Well on a Budget.

Multilevel multimodal behavioral intervention (AAR + MBI). Our published protocol[16] details this 12-week intervention of evidence-based TSE-reduction and smoking cessation treatment elements delivered across 7 modalities:

1. Up to 5 telephone counseling sessions based on cognitive behavioral therapy for smoking intervention,[19] evidence that smoking parents are motivated to modify smoking to protect children,[20–22] and our previous trials[23,24] in which initial efforts with child TSE protection are shaped toward quitting as weeks progress;
2. The BLiSS mobile app—which was modified from the National Cancer Institute's QuitPal[25] and included features for real-time self-monitoring of smoking, child TSE, smoking urges, and progress—with an app-linked dashboard guided by counselor feedback;
3. Eight weeks of NRT (via gum, patch, or lozenge);
4. Intersession text messaging with goal reminders and supportive advice;
5. Ten animated video clips via text covering topics parallel to counseling content;
6. A participant treatment binder with written information and worksheets; and
7. A family-focused smokefree home guide that contained materials (e.g., no smoking signs) to facilitate smokefree home maintenance and child TSE protection.

Measures

We obtained outcome measures via structured timeline follow-back interviews and bioverification. We assessed

child TSE as the reported number of daily cigarettes to which the child was exposed in the last 7 days, assaying urine cotinine using a validated high-performance liquid chromatography with tandem high-resolution mass spectrometry procedure (0.1 ng/mL limit of quantitation). We bioverified mothers who reported 7-day point prevalence smoking abstinence with saliva cotinine using NicAlert (Nymox Pharmaceutical Corporation, Hasbrouck Heights, NJ) or expired carbon monoxide (for participants actively using NRT).

We assessed baseline demographics, smoking history, and psychosocial variables, including variables planned as control variables in outcome analyses: nicotine dependence, other smokers at home, and depressive symptoms. We collected process measures to determine the level of participant adherence. We calculated MBI dosage by summing standardized variables representing treatment engagement: minutes of telephone counseling, number of BLiSS app page views, number of videos watched, weeks of NRT use at least 4 of 7 days, and frequency of referring to the participant binder and family guide (1 = never to 6 = 8 or more times).

Statistical Analyses

We conducted statistical analyses using STATA version 15 (StataCorp, College Station, TX) and SAS 9.4 (Cary, NC). First, we examined data distributions. Child cotinine was not normally distributed and had extreme outliers. Therefore, we winsorized values at each time point that exceeded 3 SDs (20 values exceeding 466 ng/mL), and then we log-transformed data at each time point. In our inferential analyses, we used an intention-to-treat approach. We compared change scores using random effects linear regressions, with the randomization arm as a fixed effect and clinic as a random intercept to account for potential clustering. To investigate longitudinal trends in reported TSE and cotinine levels, we used multilevel random effects regressions with random effects to account for within-subject correlation over time and within-clinic correlation. In these models, we analyzed square roots of exposure variables to normalize them.

We coded time as an ordinal variable (i.e., 0, 1, 2). For abstinence analysis, we used logistic regressions with random intercepts for clinic and survey wave indicator variables. We assessed the balance of potential confounding variables between arms using linear or logistic regressions with random intercepts to account for within-clinic correlation. Because more AAR + MBI participants than AAR + control participants reported alcohol problems at baseline ($P = .028$), we added alcohol problems (1 = yes, 0 = no) to the list of a priori control variables (e.g., other smokers). No other baseline characteristics differed between randomization arms. For missing data, we used the multiple imputation approach of Raghunathan et al.[26,27] with 25 imputed data sets. Our primary inferential analyses reported results with multiple imputations. We used complete case analyses for dosage and adherence analyses. We bounded imputed values so that none would be outside possible ranges of variables (e.g., no negative cotinine values).

RESULTS

WIC professionals advised and referred 2846 maternal smokers, of whom we randomized 396 (Figure 1). The final 12-month attrition was 12.4%, and there was no between-group difference. Table 1 displays the baseline characteristics. For child TSE from maternal smoking, there was a significant effect of time (b = −0.15; SE = 0.04; $P < .001$) and condition by time (b = −0.19; SE = 0.06; $P < .001$). Both groups reported reduced exposure to mothers' cigarettes over time, with a greater reduction among AAR + MBI mothers (Figure 2, a). Baseline nicotine dependence level (b = 0.22; SE = 0.04; $P < .001$) and number of other residential smokers (b = 0.14; SE = 0.08; $P < .046$) were significantly and positively associated with child TSE from mothers.

Change in TSE from all sources also showed significant effects of time (b = −0.15; SE = 0.05; $P = .002$) and condition by time (b = −0.21; SE = 0.07; $P = .002$; Figure 2, b) as well as significant positive associations with nicotine dependence (b = 0.22; SE = 0.05; $P < .001$) and residential smokers (b = 0.59; SE = 0.10; $P < .001$). Child cotinine results showed no effect of condition, time, or condition by time. Baseline nicotine dependence (b = 0.12; SE = 0.03; $P < .001$) and other residential smokers (b = 0.21; SE = 0.05; $P < .001$) were significantly and positively associated with cotinine. We obtained child cotinine samples from most participants who provided reported child TSE: at 3 months, we did not obtain samples from 6 AAR + control and 8 AAR + MBI participants reporting child TSE. At 12 months, we could not collect 1 AAR + control and 3 AAR + MBI samples.

There was a significant treatment effect on bioverified smoking abstinence favoring AAR + MBI (odds ratio [OR] = 9.55; 95% confidence interval [CI] = 1.54, 59.30; $P = .015$) but no effect of time or condition by time. The

TABLE 1— Participant Baseline Characteristics: Babies Living Safe and Smokefree Trial; Philadelphia, PA; 2015–2020

Participant Characteristic	AAR + Control (n = 197), Mean ±SD or %	AAR + MBI (n = 199), Mean ±SD or %	2-Tailed *P*
Maternal age, y	30.4 ±6.6	29.8 ±6.4	.31
Maternal African American race	70.1	71.4	.95
Mother married/living with partner	36.6	37.2	.84
Maternal education less than high school	60.4	62.3	.82
Maternal unemployment	53.8	62.8	.05
Maternal problem drinking (alcohol)[a]	6.1	12.6	.028
Maternal significant depressive symptoms[b]	45.2	45.2	.85
Other smokers living in home (% yes)	49.8	50.3	.87
Smoking ban in home	40.6	39.7	.97
Maternal nicotine dependence, time starts smoking after waking, min			.28
> 60	9.6	12.6	
31–60	19.3	12.6	
6–30	34.0	31.6	
< 6	37.1	43.2	
Maternal cigarettes smoked per day	8.9 ±5.2	8.8 ±5.6	.71
Child urine cotinine (log)	0.97 ±0.57	0.98 ±0.63	.88
Child age, mo	29.2 ±19.1	31.3 ±20.8	.39
Child biological female	45.2	51.3	.25

Note. AAR = Ask, Advise, Refer; MBI = multimodal behavioral intervention.

[a]Meets criteria for problem drinking on the TWEAK (tolerance, worried, eye-opener, amnesia, cut down alcohol screening test).
[b]Significant depressive symptoms (a score ≥ 10 on the 10-item CES-D [Center for Epidemiologic Studies Depression Scale]).

proportion of bioverified quitters was relatively higher in the AAR + MBI group than in the AAR + control group at 3 months (7.0% [14/199] vs 1.0% [2/197]) and 12 months (7.5% [15/199] vs 3.6% [7/197]). Bioverified abstinence was less likely for those with higher nicotine dependence (OR = 0.61; 95% CI = 0.38, 0.96; *P* = .033). Prebioverified, self-reported abstinence mirrored the pattern of bioverified results: more AAR + MBI than AAR + control participants reported abstinence at 3 months (8.0% [16/199] vs 1.0% [2/197]) and 12 months (9.5% [19/199] vs 5.1% [10/197]). Also, more AAR + MBI than AAR + control participants reported a quit attempt greater than 24 hours (69.2% vs 55.0%; *P* < .01), had more abstinent days during treatment (14.47 ±22.02 vs 3.61 ±9.85 days; *P* ≤ .001), and had more days to relapse after quitting (25.53 ±40.03 vs 14.23 ±26.70 days; *P* < .01).

Process analysis showed that 61% of participants reported that their referring WIC counselor fully complied with the "advise" step of the clinic protocol. About 90% of participants in each group received at least some telephone intervention (Figure 1). MBI group telephone counselors maintained 90.0% or greater fidelity throughout the trial: the mean fidelity score on checklists of 121 random session recordings was 9.79 ±0.49 among 10 items (1 = achieved and 0 = not achieved for each item). Table 2 shows that participants reported receiving the intended condition-specific treatment elements and that AAR + MBI participants, compared with AAR + control, reported greater effort in smoking treatment–related activities. The provision of NRT to AAR + MBI participants led to much higher NRT initiation rates in that group than in the AAR + control group. There were no group differences in use of cessation medications (e.g., varenicline) or additional counseling. For example, approximately 3% of participants in both groups reported cessation medication use; and 14.5% of AAR + control participants compared with 9.0% of AAR + MBI participants received additional treatment from the PA Free Quitline.

AAR + MBI participants completed an average of 3.10 (SD = 1.66) telephone counseling sessions, with 64.3% of participants completing more than 3

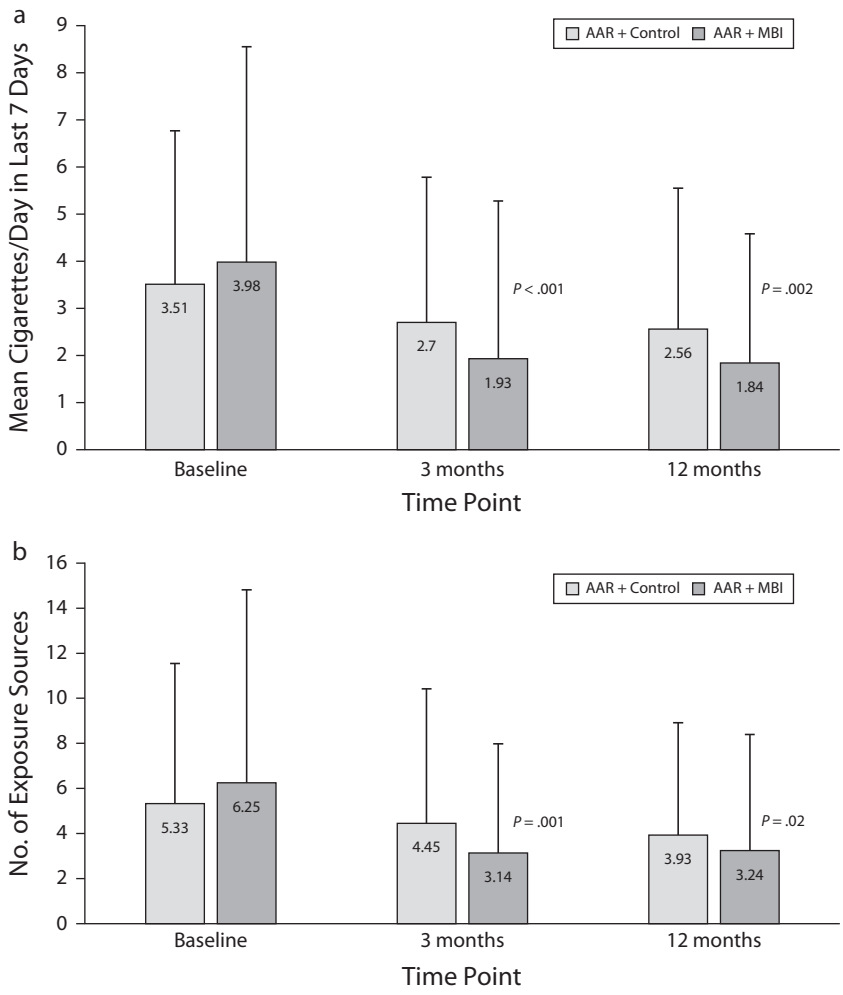

FIGURE 2— Reported Child Tobacco Smoke Exposure Between Groups (Adjusted Means and SDs): Babies Living Safe and Smokefree Trial; Philadelphia, PA; 2015–2020

Note. AAR = Ask, Advise, Refer; MBI = multimodal behavioral intervention.

sessions. Mean app use was 16.48 (SD = 17.52) days, with most use occurring in the first week and tapering over time. Despite more than half of AAR + MBI participants initiating NRT, only 14.3% used NRT at least 4 days per week over 8 weeks. Approximately 68% referred to their participant written materials more than once (28.9% did so 4 or more times), and 50.9% used the family guide more than once (16.8% did so 4 or more times), whereas 91.5% watched at least 1 video (60.8% watched at least 4). Greater treatment dosage across all treatment modalities was associated with lower reported child TSE to maternal smoking (r = −0.24; *P* = .038) and all sources (r = −0.26; *P* = .024) at 3 months and more days abstinent during treatment (r = 0.26; *P* = .02).

Dosage–outcome associations within modalities suggested that telephone counseling was the most integral mode of intervention. For example, completing more BLiSS counseling sessions was related to the following outcomes: lower child cotinine at 3 (r = −0.19; *P* = .016) and 12 months (r = −0.24; *P* = .002), bioverified abstinence at 3 months (r = 0.19; *P* = .01), adoption of an indoor smoking ban at 3 (r = 0.23; *P* = .001) and 12 months (r = 0.18; *P* = .013), lower reported child TSE from maternal smoking (r = −0.23; *P* = .003) and all sources (r = −0.24; *P* = .001) at 3 months, and more days abstinent during treatment (r = 0.34; *P* < .001). By contrast, more weeks of NRT use and more app use did not relate to outcomes. Greater use of videos was associated with lower child cotinine at 3 months (r = –0.16; *P* = .04) and more abstinent days during treatment and follow-up (*P* < .01).

DISCUSSION

Our primary hypothesis that the AAR + MBI intervention would promote greater reductions in child TSE than the AAR + control intervention was supported by reported TSE results, consistent with results showing that AAR + MBI mothers were more likely to adopt residential smoking bans. However, there was no change in child cotinine in either group. Results did support our hypothesis that the AAR + MBI participants would demonstrate higher bioverified abstinence rates than the AAR + control group. AAR + MBI participants also had more days abstinent and days to relapse. Higher baseline nicotine dependence was associated with less success across all outcomes, and having more smokers living in the home was associated with greater child exposure.

The treatment effects on reported TSE reduction and adoption of residential smoking restrictions in this trial were consistent with previous studies.[11,23,24] Our result showing no child cotinine reductions in either group is inconsistent with some previous findings.[11] For example, in some trials, child

TABLE 2— Group Differences in Intervention Efforts Assessed at 3-Month Follow-Up: Babies Living Safe and Smokefree (BLiSS) Trial; Philadelphia, PA; 2015–2020

Intervention Process Variable	AAR + Control (n = 197), Mean ± SD	AAR + MBI (n = 199), Mean ± SD	1-Tailed *P*
Learned new information about nutrition[a]	3.55 ±0.66	3.18 ±0.84	< .001
Learned how sugary drinks can be unhealthy[a]	3.51 ±0.68	2.96 ±0.93	< .001
Learned new strategies for quitting smoking[a]	2.81 ±0.95	3.34 ±0.77	< .001
How often did you use the BLiSS family guide[b]	2.04 ±1.09	2.34 ±1.05	.009
How often did you use the project app[b]	3.81 ±1.72	4.73 ±1.59	< .001
How often did a counselor support your effort to change smoking (TSE reduction, cessation)[c]	9.85 ±2.32	10.67 ±1.84	< .001
How often do you protect your child from TSE[d]	35.26 ±5.03	36.56 ±5.22	.001
Do you have household restrictions around indoor smoking[e]	2.22 ±0.61	2.34 ±0.60	.040
How often do you use urge management strategies[f]	28.59 ±8.26	31.76 ±9.67	< .001
Have you used any nicotine replacement therapy (yes)	8.3	54.1	< .001

Note. AAR = Ask, Advise, Refer; MBI = multimodal behavioral intervention; TSE = tobacco smoke exposure.

[a]Single item: 1 = strongly disagree to 4 = strongly agree.
[b]Single item: 1 = never, 2 = once, 3 = 2–3 times, 4 = ≥4 times.
[c]4-items: 1 = never, 2 = rarely, 3 = sometimes, 4 = always.
[d]11-items, cross-context TSE protections: 1 = never, 2 = rarely, 3 = sometimes, 4 = always.
[e]Single item: 1 = no restrictions, 2 = smoking only in designated spaces, 3 = indoor ban.
[f]12-items: 1 = never, 2 = rarely, 3 = sometimes, 4 = often.

cotinine decreased equally in both experimental and control groups over time. We are aware of only 1 trial targeting low-income maternal smokers that demonstrated greater bioverified TSE reduction in experimental versus control groups.[23] However, compared with BLiSS, that trial's experimental group had more counseling sessions over 16 weeks. This point has relevance, considering the AAR + MBI within-group analysis: greater counseling dosage was related to significantly lower child cotinine. Additionally, improving WIC counselor adherence to AAR could improve the impact of multiple channels delivering TSE-reduction messaging. Better provider adherence (> 80% of participants reporting pediatricians' full compliance to AAR procedures) occurred in our previous primary care–initiated multilevel intervention,[24] and child cotinine declined significantly in the entire study sample.

Plausible explanations for the null child cotinine results, despite reported reductions in child TSE, include limitations of reported versus observable measurement of TSE. For example, when reporting child TSE, participants are asked to recall days, times, locations, and sources of exposure. They may miss TSE occurring when their child is not in their direct care. Additionally, even though maternal smoking is a primary source of child TSE, cotinine levels can be affected by thirdhand smoke contamination, which tends to be elevated in low-income residential units even when parents report no indoor smoking.[28,29] Residual tobacco contaminants and nicotine accumulation on indoor surfaces, walls, and furnishings are redispersed for months—even after smokefree home adoption or cessation. In 1 study,[30] child cotinine and residential tobacco contaminants were 5 to 7 times higher in homes of smokers who achieved indoor smoking bans than in nonsmokers' homes. Such evidence points to the importance of promoting household smoking bans and maternal smoking abstinence.

The abstinence results in this trial are notable, particularly because the sample of high-risk maternal smokers was not seeking smoking treatment at the WIC clinic encounter (AAR). Moreover, the outcome was bioverified and the treatment effect was observed using an attention control that included a clinic-based tobacco intervention. In a systematic review of trials targeting smoking parents, only 1 of 18 studies used a tobacco intervention control group and demonstrated the main effect of treatment on bioverified abstinence rates.[31] Two more recent trials targeting smoking parents have demonstrated main effects of experimental treatment on bioverified abstinence rates compared with a standard care

tobacco intervention control group.[23,24] Another notable finding was the AAR + MBI group's high rate of NRT initiation, given the pervasively low uptake of NRT in low-income and racial minority communities. However, relatively few participants reported sustained NRT use, and greater use was not related to cessation. More individual-level counseling to guide proper NRT use or incentives to motivate sustained NRT use could facilitate a greater likelihood of cessation.

Although results suggest promising potential for the multilevel BLiSS intervention for low-income maternal smokers, the null cotinine results and relatively low absolute quit rates warrant future modifications and enhancements. An ecological framework could guide the integration of enhancements targeting multiple determinants of smoking across levels of influence. For example, at the biological level, future trials could address the effects of elevated nicotine dependence on TSE and cessation outcomes and enhance NRT effects on cessation with combination NRT. At the clinic level, future trials could improve providers' AAR adherence by embedding decision aids in electronic health systems. Because the family-level treatment components in BLiSS were minimal and the effect of other smokers in the home undermined TSE protections, future trials could explore the utility of family counseling components. At the community and policy levels, health communication campaigns and tobacco legislation (including zoning that restricts proliferation of tobacco vendors in low-income neighborhoods) could amplify WIC agency efforts encouraging families to reduce child TSE.

Finally, BLiSS outcomes suggest that behavioral counseling grounded in social cognitive theory and cognitive behavioral therapy processes that target individual-level determinants could be the keystone in a multilevel intervention for smoking behavior change. Based on our evidence that higher dosage of telephone counseling was related to improved outcomes, future studies could explore ways to improve participants' treatment engagement. One evidence-based strategy is contingency management with financial incentives to facilitate session adherence and bioverified abstinence.[32,33] The potential utility of financial incentives as an adjunct in the BLiSS model is compelling, particularly given the increasing enthusiasm for this method among key stakeholders, including public and private insurers.[34]

Limitations

Limitations in this trial include incomplete information about AAR implementation. Our interpretation of results is also limited to the target population and inclusion criteria constraints on the sample. However, we assert that the BLiSS model is a pragmatic treatment model that could be translated to reach and engage broader populations of low-income smokers (an assertion a future dissemination and implementation trial could test). Similarly, a more pragmatic approach with fewer efficacy trial–related constraints would help inform future dissemination efforts.

Public Health Implications

Our findings suggest that a multilevel MBI package initiated in WIC was acceptable, feasible, and efficacious in promoting long-term smoking abstinence and reported child TSE reduction. Importantly, these results occurred in a population that experiences elevated barriers to initiating smoking treatment and achieving abstinence. Because we designed BLiSS as a pragmatic intervention (embedded in routine patient flow, based on standard care for clinic-based intervention, and modeled after quitline best practices), this approach could be readily adopted across state WIC systems or similar community-based safety net programs in partnership with state quitlines. Such implementation would be similar to existing medical system e-referral links to quitlines. Therefore, disseminating this approach would have a large impact on a persistent public health priority, reducing tobacco-related morbidity and mortality in low-income communities bearing the greatest burden.

Future iterations of the BLiSS approach could improve smoking treatment outcomes further by including strategies that use the growing evidence that treatment adherence and abstinence rates can be increased with contingency management—an intervention strategy gaining favor among public and private insurers.[34] To improve child TSE-reduction outcomes, future treatments could include programming to reduce thirdhand smoke (the residual environmental nicotine and tobacco contaminants that affect exposure and cotinine levels even after indoor smoking bans and cessation). Embedding future, novel intervention strategies in a behavioral ecological framework could amplify treatment effects on abstinence and child TSE outcomes through synergistic influences across levels of behavior change determinants. AJPH

ABOUT THE AUTHORS

Bradley N. Collins and Stephen J. Lepore are with the Department of Social and Behavioral Sciences, College of Public Health, Temple University, Philadelphia, PA. Brian L. Egleston is with the

Biostatistics and Bioinformatics Facility, Fox Chase Cancer Center, Philadelphia, PA.

CORRESPONDENCE

Correspondence should be sent to Bradley N. Collins, PhD, 1701 Cecil B. Moore Ave, Ritter Annex 951, College of Public Health, Philadelphia, PA 19122 (e-mail: collinsb@temple.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

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CONTRIBUTORS

B. N. Collins drafted the article, developed and oversaw the implementation of the telephone-based behavioral counseling intervention, and developed and supervised intervention training and fidelity monitoring of the smoking and nutrition interventions. B. N. Collins and S. J. Lepore developed the study concept and aims and the initial analytic plan, animated health education video clips, modified the QuitPal app that became the BLiSS research app used in the trial, operationalized and designed the WIC clinic intervention protocol, and implemented the WIC intervention training, fidelity monitoring, and fidelity feedback protocols. S. J. Lepore developed the telephone-based nutrition counseling intervention and developed the data quality assurance training and feedback protocols. B. Egleston finalized the analytic plan and allocation schedule, oversaw randomization procedures, and conducted data analyses. All authors interpreted the analytic results and contributed to and approved the final version of the article.

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CONFLICTS OF INTEREST

The authors do not have any conflicts of interest to disclose.

HUMAN PARTICIPANT PROTECTION

The Temple University institutional review board approved this study (protocol 23188), and the participants' written informed consent was required for their participation in the study.

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