ORIGINAL INVESTIGATION

A Randomized, Controlled Community-Wide Intervention to Reduce Environmental Tobacco Smoke Exposure

Mary Kate Mohlman MS¹, Dina N. K. Boulous PhD², Maged El Setouhy PhD², Ghada Radwan PhD³,
Kepher Makambi PhD⁴, Irene Jillson PhD⁵, Christopher A. Loffredo PhD⁴

¹Department of Microbiology and Immunology, Georgetown University, Washington, DC; ²Department of Community, Environmental, and Occupational Health, Ain Shams University, Cairo, Egypt; ³Department of Community Medicine, Cairo University, Cairo, Egypt; ⁴Departments of Oncology and Biostatistics, Bioinformatics and Biomathematics, Georgetown University, Washington, DC; ⁵Department of Nursing, Georgetown University, Washington, DC

Corresponding Author: Christopher A. Loffredo, Ph.D., Lombardi Cancer Center, Georgetown University, 3800 Reservoir Road NW, Washington, DC 20057, USA. Telephone: 202-687-3758; Fax: 202-784-3034; E-mail: cal9@georgetown.edu

Received July 23, 2012; accepted December 3, 2012

ABSTRACT

Introduction: Tobacco use in low- to middle-income countries is a major public health concern for both smokers and those exposed to environmental tobacco smoke (ETS). Egypt has made important strides in controlling tobacco use, but smoking and ETS remain highly prevalent. This randomized intervention sought to improve the target population's knowledge regarding the hazards of smoking and ETS and to change attitudes and smoking behaviors within the community and the household.

Methods: In this 2005–2006 study in Egypt's Qalyubia governorate, trained professionals visited schools, households, mosques, and health care centers in rural villages randomly selected for the intervention to discuss the adverse effects of smoking and ETS exposure and ways to reduce one's ETS exposure. Data collected in interviewer-facilitated surveys before and after the intervention period were analyzed in pairwise comparisons with data from control villages to assess the effectiveness of the intervention in achieving its aims.

Results: The intervention group showed a greater increase in understanding the dangers associated with smoking cigarettes and waterpipes and became more proactive in limiting ETS exposure by asking smokers to stop, avoiding areas with ETS, and enacting smoking bans in the home. However, the intervention had little to no impact on the number of smokers and the amount of tobacco smoked.

Conclusions: Results are consistent with previous studies showing that changing smokers' behavior can be difficult, but community-wide efforts to reduce ETS exposure through smoking bans, education, and empowering people to ask smokers to stop are effective. The method can be generalized to other settings.

INTRODUCTION

Tobacco use worldwide and especially in low- to middle-income countries, where 80% of the world's estimated 1 billion smokers live (World Health Organization, 2011a), continues to be a major public health concern, with effects seen not only in smokers but also in those exposed to environmental tobacco smoke (ETS).

Scientific evidence suggests a causal relationship between ETS exposure and tobacco-related diseases including chronic respiratory conditions, acute coronary disease, and lung cancer (U.S. Department of Health and Human Services, 2006; World Health Organization, 2011b). A 2010 study published in the *Lancet* focused on the worldwide burden of disease from exposure to secondhand smoke. The results indicated that

globally, 40% of children, 33% of male nonsmokers, and 35% of female nonsmokers were exposed to secondhand smoke in 2004. The largest disease burdens were lower respiratory infections in children younger than 5 years, ischaemic heart disease in adults, and asthma in children and adults (Öberg, Jaakkola, Woodward, Peruga, & Prüss-Ustün, 2011). Additionally, infants and children exposed to ETS have a higher risk of Sudden Infant Death Syndrome and otitis media (Environmental Protection Agency, 2011). For pregnant women, exposure to secondhand smoke is associated with low birth weight, premature delivery, spontaneous abortion, perinatal conditions, and congenital malformations (National Cancer Institute and State of California, 1999). Studies in the Middle East have confirmed the association between exposure to secondhand smoke with low birth weight and premature delivery (Khader, Al-Akour,

doi:10.1093/ntr/nts333

Advance Access publication January 17, 2013

© The Author 2013. Published by Oxford University Press on behalf of the Society for Research on Nicotine and Tobacco. All rights reserved. For permissions, please e-mail: journals.permissions@oup.com

AlZubi, & Lataifeh, 2010; Wadi & Al-Sharbatti, 2011). Finally, two recent studies showed that reducing ETS exposure had a positive effect on health. Specifically, these studies identified an association between smoking bans in public areas and the workplace and a decrease in the incidence of sudden cardiac death and respiratory and cardiac disease (Hurt et al., 2012; Tan & Glantz, 2012).

Egypt has made important strides in efforts to control tobacco use and reduce its adverse health effects. As a signatory nation to the Framework Convention on Tobacco Control, it has enacted laws and regulations to ban indoor smoking in many public places and has imposed taxes on cigarette sales. However, tobacco consumption remains high—19.4% of adults (37.7% of men and 0.5% of women) report smoking some form of tobacco. Regarding ETS exposure, 60.7% of adults report exposure in the workplace and 81.5% report exposure at home (World Health Organization Regional Office for the Eastern Mediterranean, 2010a). Additionally, 79.6% of adults report exposure to ETS on public transportation, 72.7% report exposure in restaurants, 72.8% report exposure in government buildings, and 49.2% in health care facilities (World Health Organization Regional Office for the Eastern Mediterranean, 2010b). These high levels are attributed to lax enforcement of existing antitobacco regulations, a paucity of successful intervention models applicable to local needs, a shortage of trained experts, a lack of avoidance behavior by nonsmokers, and a gap in knowledge on the health effects of and attitudes toward waterpipe smoking—a highly prevalent method of tobacco consumption in the country (Gharaibeh et al., 2011; Mohamed, Loffredo, & Israel, 2006; Radwan, Loffredo, Aziz, Abdel-Aziz, & Labib, 2012).

This study addressed these shortfalls through its primary goal of reducing ETS exposure for women and children specifically and nonsmokers generally. It focused on supplementing Egypt's "top-down" regulatory approach to tobacco control with a "bottom-up" strategy of outreach and education. By emphasizing the impact of smoking on one's own health and of secondhand smoke on the health of family members and nonsmokers, the intervention sought to change attitudes and smoking behaviors in the community and household.

METHODS

Study Population and Sampling Methods

Cluster sampling methods were used to select the population initially. Villages in the Qalyubia governorate of Egypt were assessed for the following criteria: a population between 10,000 and 20,000 persons; at least one primary, preparatory, and secondary school; a public health clinic; a youth club; and a mosque. Within the Qalyubia governorate, two districts were randomly chosen, Al Kantr Al Kheiyerva and Qalyoub. In each, eight villages met the selection criteria. Four villages randomly selected in Al Kantr Al Kheiyerva and five villages randomly selected in Qalyoub were used to establish preliminary data on socioeconomic status and smoking behaviors. The selected villages had to be at least 10 miles apart to limit "contamination" of the control villages from intervention villages after randomization. Three villages were used for testing questionnaires and study procedures, and these villages were not involved in further stages of the research. The remaining six villages were

randomly allocated to either the control group or the intervention group, each of which included three villages. All villages had access to Egypt's National Tobacco Control Program during the study.

A field team visited each of the six study villages prior to the baseline data collection phase of the study, conducted a complete census, and drew a detailed map that noted the location of each house and landmarks such as schools, health facilities, and mosques. Each house was assigned a unique identification number. Three hundred houses per village were selected through a systematic random sampling technique. The study recruiters visited each of the villages and identified the geographic center, randomly selected a cross street, and then used a systematic random sampling method to approach residents on both sides of the street. If none of the house occupants matched the required gender and ages (see below), the recruitment team moved to the next house. After all houses had been visited on the street, the team selected the next cross street and continued. Once a potentially eligible participant was identified in a household, the interviewer explained the study and offered participation.

Consent and Preintervention Interview Procedures

All household members age 12 and above in all six villages were invited to participate in the study. Each adult participant (age 18 and above) signed an informed consent form, or if illiterate, had a witness sign for him or her. Adolescents (ages 12–17) had to sign an assent of participation form after one of their parents signed their approval for participation. Two interviewer-administered preintervention (baseline) questionnaires were used in each household: one for adults and one for adolescents. The scope of this article is limited to data from the adult survey, which included four categories of questions: (a) sociodemographic and smoking behavior (including current age, level of education, marital status, occupation, current and former smoking status, and level of exposure to ETS); (b) sources of information on the hazards of smoking and ETS (including media, medical care providers, family members, and religious clerics); (c) knowledge about the hazards of smoking and ETS (including health effects on children, adults, and pregnant women, and the relative hazards of shisha vs. cigarettes); and (d) the behavior of smokers and of nonsmokers exposed to ETS (including where smokers smoked, reactions of nonsmokers to smokers, and implementation of smoking bans). Most questions were multiple choice, with the majority being dichotomous yes/no questions. All open-ended questions were limited to quantitative responses such as age or number of cigarettes smoked. One question asking, "Are you convinced of banning smoking in the following places?" involved a rating scale response for the places listed.

For purposes of the study, current smokers included all persons who had smoked at least 100 cigarettes in their lifetime and at least 1 day in the previous month. Former smokers were persons who had smoked at least 100 cigarettes in their lifetime but had not smoked in the previous month. A nonsmoker was a person who had never smoked (not even a puff) or smoked less than 100 cigarettes in his or her lifetime and was not currently smoking. A current waterpipe smoker (*shisha*) was defined as a person who had smoked a waterpipe at least once in the last month.

The outcome measures assessed included asking someone to stop smoking, smoking in public places such as on public

transportation, smoking shisha or cigarettes, implementing a smoking ban in the home, avoiding exposure to ETS, and changes in knowledge about hazards of smoking and ETS.

Intervention Description

The study team met with community leaders to build support and ensure that the intervention could be executed smoothly. All those involved in implementing the intervention participated in training activities. All trainees received a guide booklet, a pamphlet on smoking and passive smoking hazards, and CDs with lectures on smoking hazards.

The intervention consisted of a five-prong approach. In the first prong, primary school students participated in traditional and nontraditional activities aimed at preventing the initiation of smoking by deglamorizing tobacco use and teaching about its health hazards. In the second, preparatory and secondary school students engaged in an experiential learning program to develop social skills among teenagers to handle peer pressure to smoke. The third engaged mosques and churches in educating their communities about the hazards of smoking and ETS and in raising the issue of smoking as a sinful behavior (a position supported by current Islamic jurisprudence and the Coptic Orthodox Pope's advice). All participants in the study identified themselves as Muslim; so all inquiries involving religion focused on the Islamic faith. In the fourth prong, female social change agents (*raedat refeyat*) provided information to adult women in the home on the negative health effects of tobacco use and ETS. They also taught these women how to better protect themselves and their children from ETS through a standardized message sensitive to cultural family dynamics. This was done to avoid conflict with the smoker in the family, who was most often the husband. The intervention team relied solely on personal contacts with the women since some households did not have access to telephones.

Intervention Delivery and Postintervention Survey

Baseline data were collected from November 2004 to July 2005. Within 3 months of completion, the five prongs of the intervention were initiated simultaneously in the three intervention villages and lasted over a 12-month period. Then, in all six villages, a postintervention survey with the same format as the preintervention survey was carried out from July to August 2006, targeting the same respondents from the preintervention survey.

Data Processing and Statistical Analysis

Data were collected, revised, coded, and double entered, and Microsoft Access (2003) was used for data entry. Data from the preintervention survey were used to establish a baseline for socioeconomic information and smoking behaviors. Quantitative variables were analyzed using the nonparametric Mann-Whitney *U* test to evaluate any differences between the control and intervention medians. For categorical data, chi-square tests were used to determine differences in responses between the two groups. An α level of .05 was used for significance.

For the majority of variables in the pre- and postintervention surveys, pairwise analysis was used. Variables that were not normally distributed were analyzed using the nonparametric Wilcoxon signed-rank sum test to identify differences. For

dichotomous variables, McNemar tests were used to assess differences in response rates. This was done separately for the control and intervention groups. There were two types of variables regarding the intervention's efficacy that did not meet the requirements for paired analysis. The first were questions included only in the postintervention survey. In these cases, the responses by the control and the intervention groups were compared in a manner similar to the baseline data. The second included questions for which the categorical responses to a question were not dichotomous. For these, chi-square tests for both the control villages and the intervention villages were presented.

Both the pre- and postintervention surveys included questions in which respondents were asked for their positions, for example, "reasons to stop smoking": health—yes or no, money—yes or no, and so forth. The percentage of "yes" responses for each subvariable of the series was evaluated to compare the differences between the groups at both the pre- and postintervention stages. The statistical analysis also explored changes in responses from before and after for each group.

Finally, the general estimating equation, using a binomial family and logit link, was employed to adjust for variables such as age or gender when looking for differences between the control and intervention groups in relation to the target-dependent variable. The adjusted odds ratios were reported for predictor variables in the model. Stata 12 software was used for statistical analysis.

RESULTS

Study Population

In the intervention villages, 88.9% of the randomly selected households were contacted (i.e., residents were present and agreed to talk to the team); the refusal rate among these households was 1.3%. The contact rate in the control villages was 91.3%, with a refusal rate of 0.9%. The total number of respondents who participated in the preintervention study was 7,657. Each of the households that participated in the preintervention was approached following the intervention. In this phase of the study, there was a contact rate of 98.1% in the intervention villages, and of those households, a 98.6% participation rate. In the control villages, there was a contact rate of 98.6%, and of those households, a 99.0% participation rate. In some cases, there were new families or new members of the household at these addresses; therefore, the study population includes some individuals who participated in the postintervention but not the preintervention. However, for the purposes of this study, the analysis included only the 5,934 individuals who participated in both surveys for an overall 77.5% retention rate. This same retention rate was also seen in both the control and intervention subgroups.

Preintervention Characteristics and Smoking Behavior

The demographic profiles and baseline smoking behaviors (Table 1) of both the control and intervention groups were very similar. There was no statistically significant difference in the median age, gender ratio, education, employment, and marital status, although there were slightly more married respondents in the control group. Similarities were seen in the numbers

Table 1. Demographics and Baseline Smoking Behavior

Category	Statistics	Control: <i>N</i> (%)	Intervention: <i>N</i> (%)	<i>p</i> value
Age	Mean	36.16	36.88	.1205
	Median	34	33	
	Range	18–82	18–85	
	<i>N</i>	3122	2776	
Age started regularly smoking	Mean	14.81	16.67	<.0001
	Median	16	17	
	Range	1–53	0–60	
	<i>N</i>	840	742	
Number of days respondents smoked per month	Mean	17.49	17.61	.6595
	Median	30	30	
	Range	0–30	0–30	
	<i>N</i>	841	743	
Number of cigarettes smoked per day	Mean	18.70	17.67	.3462
	Median	20	20	
	Range	1–60	1–59	
	<i>N</i>	508	455	
How many years have you smoked this amount?	Mean	9.67	10.25	.4432
	Median	5	6	
	Range	0–60	0–60	
	<i>N</i>	509	455	
Money spent on cigarettes per month	Mean	69.30	65.51	.9951
	Median	70	75	
	Range	0–720	0–250	
	<i>N</i>	509	455	
Number of times a day you smoke <i>shisha</i>	Mean	2.98	3.44	.0462
	Median	2	3	
	Range	1–20	1–30	
	<i>N</i>	167	198	
Number of days a week you smoke <i>shisha</i>	Mean	5.60	5.64	.7408
	Median	7	7	
	Range	0–7	0–7	
	<i>N</i>	166	195	
Number of stones of <i>shisha</i> smoked per day	Mean	1.98	2.01	.4836
	Median	1	2	
	Range	0–10	0–10	
	<i>N</i>	167	196	
Number of times tried to stop smoking <i>shisha</i>	Mean	0.64	0.93	.1611
	Median	0	0	
	Range	0–10	0–6	
	<i>N</i>	175	207	
Category	Group	Control: <i>N</i> (%)	Intervention: <i>N</i> (%)	<i>p</i> (χ^2 test)
Sex	Male	1404 (44.74)	1244 (44.49)	.847
	Female	1734 (55.26)	1552 (55.51)	
Marital status	Never married	585 (18.65)	568 (20.34)	.028
	Divorced	26 (0.83)	11 (0.39)	
	Widowed	215 (6.86)	216 (7.73)	
	Married	2310 (73.66)	1998 (71.54)	
Highest education	Do not read/write	1270 (40.47)	1168 (41.77)	.131
	Primary	606 (19.31)	551 (19.71)	
	Preparatory	218 (6.95)	175 (6.26)	
	Secondary	791 (25.21)	721 (25.79)	
	Postsecondary	253 (8.06)	181 (6.47)	
Do you work?	No	390 (12.43)	355 (12.70)	.755
	Yes	2748 (87.57)	2441 (87.30)	

of smokers in each group, with approximately one quarter of the participants in both groups reporting taking at least one puff of a cigarette in their lifetime. Only three women self-reported smoking, a number too small to include in analysis on smoking behaviors, so smokers considered in this analysis were limited to male smokers, which made up 15.9% of the control group and 14.7% of the intervention group (data not shown). Similar proportions of men in both groups (17%) reported recent waterpipe (*shisha*) smoking (data not shown). **Table 1** also shows no difference in the amount and frequency of tobacco consumption. The two exceptions were average age at which respondents started smoking (16 years in the control group and 17 years in the intervention group) and the number of times a day *shisha* smokers smoked (a median of 2 times per day in the control group compared with 3 times per day in the intervention group).

Source of Information Regarding Smoking

Respondents were asked about their sources of information in the past year on smoking and its hazards (data not shown). The intervention group was more likely to have a rural health unit doctor or nurse ask if the respondent smoked compared with the control group (control: 20.3%, intervention: 27.8%; $p < .01$). They were also more likely to have attended a sporting event advertised as nonsmoking (control: 13.0%, intervention: 27.0%; $p < .0001$). However, there was no difference in respondent participation at these events (control: 53.7%, intervention: 59.6%; $p = .30$). Finally, the intervention respondents had a much higher affirmative response to whether a *raedat* had visited the household to discuss the hazards of smoking and ETS (asked only in the postintervention survey), which would be expected since the *raedat* visit was a main component of the study.

Knowledge About Smoking and Its Effects

Table 2 presents the respondents' knowledge of the relative dangers of smoking cigarettes or *shisha*. The intervention group saw a 25.6% increase (38.3%–48.1%) in the belief that *shisha* is *not* less harmful than cigarettes compared to a 10.8% increase (40.6%–44.9%) in the control group. Furthermore, the intervention group experienced a 20.9% decrease (48.8%–38.6%) in not knowing whether *shisha* was less harmful compared to an 11.2% decrease (48.5%–43.1%) in the control group. Overall, these trends suggest a significantly greater knowledge gain in the intervention group on the relative hazards of smoking *shisha* and cigarettes.

Table 2 also shows data on whether respondents perceived that antismoking messages included information on the specific effects of smoking and ETS on children, adults, and pregnant women. In all categories, the intervention group had a significantly greater perception of being exposed to the information than the control group. For example, 36.8% of intervention respondents compared to 25.5% of control respondents stated they had received information that children exposed to ETS have more frequent common colds.

Smoking Behavior

While there were no statistically significant differences in the numbers of current smokers before and after the intervention, **Table 3** identifies some important changes in the locations

where smokers smoked and in nonsmokers' ability to ask others to stop smoking. For example, respondents in the intervention group were 4.5 times more likely to smoke on public transportation before the intervention than after. The control respondents were only 2.8 times more likely to do the same. Additionally, intervention respondents were 2 times more likely to have smoked *shisha* before than after the intervention; there was no significant change in the control group. On the subject of asking smokers to stop, both the control (OR 0.8) and intervention (OR 0.6) respondents were less likely to ask someone on public transportation to stop smoking before the intervention than after, a trend true to a greater degree in the intervention group. Respondents in the control group were less likely to ask a relative to smoke outside before the intervention than after (OR 0.8); however, relatives were more likely to agree to the request before the intervention (OR 1.7). Finally, control respondents were less likely to ask a stranger to stop smoking before the intervention than after (OR 0.7). There were no significant changes in responses from the intervention group in these last three questions.

On the issue of a smoking ban in all or part of the home, both the control (OR 0.56) and intervention (OR 0.3) groups were less likely to have a ban before the intervention than after; however, this trend was clearer in the intervention group. Lastly, respondents in the intervention group were 0.9 times less likely to avoid places where they would be exposed to smoking before the intervention than after, while control respondents were 1.13 *more* likely to avoid exposure before than after the intervention.

When nonsmoker respondents were asked why they avoided areas with exposure to smoking (data not shown), the majority of respondents, both before and after the intervention, gave their own health as the reason. Other options included the child's and family's health. Of interest is that both groups showed a decrease in those who responded "self" (control: –8.4% change from 80.6% to 73.8%; intervention: –13% change from 87.3% to 75.9%), and an increase in those who stated "children" (control: 258.4% change from 1.37% to 4.9%; intervention: 100.6% change from 1.53% to 3.1%) and "family" (control: 17.7% change from 18.1% to 21.3%; intervention: 89.1% change from 11.1% to 21.1%) as a response.

When nonsmokers were asked what they did in a public area with smokers, the response options included asking the smoker to stop, leaving the area, doing nothing, or becoming angry. The distribution of pre- and postintervention responses was very similar for both groups, with the exception of the increase in intervention respondents who said they would ask the smoker to stop (33.3% change from 22.6% to 30.1%). The percentage of control respondents who gave the same answer showed a slight decrease (–0.5% change from 25.9% to 25.4%).

Our final step in analyzing the behavioral variables focused on those variables that showed a significant difference pre- to postintervention for both groups in the bivariate analysis (**Table 4**). The question "In the last month, have you smoked on public transportation?" that was targeted at current and former smokers revealed a significant difference ($p = .002$) between groups when adjusted for age, marital status, education, work status, and smoker status: the intervention group was 1.65 times more likely to have smoked on transportation before the intervention when compared to after. The next two outcome

Table 2. Knowledge Variables

Category	Preintervention	Control: N (%)	Intervention: N (%)	p (χ^2 test)	Postintervention	Control: N (%)	Intervention: N (%)	p (χ^2 test)
Is smoking <i>shisha</i> less harmful than smoking cigarettes?	No Yes	1273 (40.57) 342 (10.90)	1071 (38.30) 361 (12.91)	.030	No Yes	1407 (44.94) 375 (11.98)	1342 (48.12) 370 (13.27)	.002
Did info on smoking mention that exposure can cause _____ in children?	Do not know Not assessed in preintervention	1523 (48.53)	1364 (48.78)		Do not know	1359 (43.09)	1077 (38.62)	
Frequent common colds					No	2327 (74.16)	1767 (63.22)	<.0001
Asthma					Yes	811 (25.84)	1028 (36.78)	
Otitis media					No	1347 (42.93)	980 (35.08)	<.0001
Lung cancer					Yes	1791 (57.07)	1814 (64.92)	
Asthma					No	3118 (99.39)	2607 (93.34)	<.0001
Coronary thrombosis					Yes	19 (0.61)	186 (6.66)	
Stroke					No	2372 (75.66)	1584 (56.71)	<.0001
Abortion					Yes	763 (24.34)	1209 (43.29)	
Preterm delivery					No	1448 (46.14)	1036 (37.07)	<.0001
Fetal death					Yes	1690 (53.86)	1759 (62.93)	
					No	3012 (96.02)	2442 (87.43)	<.0001
					Yes	125 (3.98)	351 (12.57)	
					No	3114 (99.30)	2633 (94.27)	<.0001
					Yes	22 (0.70)	160 (5.73)	
					No	2971 (94.71)	2267 (81.11)	<.0001
					Yes	166 (5.29)	528 (18.89)	
					No	2646 (84.35)	2021 (72.31)	<.0001
					Yes	491 (15.65)	774 (27.69)	
					No	3026 (96.49)	2392 (85.58)	<.0001
					Yes	110 (3.51)	403 (14.42)	

Table 3. Behavior Variables—Categorical Pairwise Analysis

Category	Control villages			Intervention villages		
	Prevalence (%)—"yes"		OR (95% CI)	Prevalence (%)—"yes"		OR (95% CI)
	Before but not after	After but not before		Before but not after	After but not before	
Do you smoke now?	39 (5.9)	43 (6.5)	0.91 (0.57, 1.43)	46 (8.3)	38 (6.9)	1.21 (0.77, 1.91)
In the last month, did you smoke in a train, bus, or microbus?	45 (10.1)	16 (3.6)	2.81 (1.56, 5.33)	54 (14.0)	12 (3.1)	4.5 (2.38, 9.24)
Do you avoid going to certain places where smoking is forbidden?	29 (6.5)	13 (2.9)	2.23 (1.12, 4.67)	23 (5.9)	20 (5.2)	1.15 (0.60, 2.21)
If you are in a hospital, will you smoke?	38 (8.6)	24 (5.4)	1.58 (0.93, 2.76)	39 (10.1)	19 (4.9)	1.58 (0.86, 2.97)
Have you stopped smoking now?	6 (7.0)	7 (8.1)	0.86 (0.24, 2.98)	13 (13.3)	14 (14.3)	0.93 (0.40, 2.13)
Did you smoke <i>shisha</i> last month?	25 (8.6)	20 (6.9)	1.25 (0.67, 2.37)	28 (11.2)	14 (5.6)	2 (1.02, 4.11)
Do you want to stop smoking?	35 (6.3)	30 (5.4)	1.67 (0.70, 1.97)	31 (6.0)	29 (5.6)	1.07 (0.62, 1.84)
Do you think you can stop smoking?	31 (9.3)	35 (10.5)	0.89 (0.53, 1.48)	27 (9.0)	31 (10.3)	0.87 (0.50, 1.51)
Will you stop smoking?	23 (16.3)	14 (10.0)	1.64 (0.81, 3.45)	38 (20.5)	8 (4.3)	4.75 (2.18, 11.79)
Can you ask any of your relatives living with you to smoke outside?	395 (12.6)	471 (15.0)	0.84 (0.73, 0.96)	421 (15.2)	401 (14.3)	1.05 (0.91, 1.21)
Do your relatives agree to smoke outside when asked?	53 (24.0)	32 (14.5)	1.66 (1.05, 2.65)	43 (21.0)	40 (19.5)	1.08 (0.68, 1.70)
(includes "yes" and "sometimes")						
Is there a place in the home where smoking is forbidden?	298 (9.0)	531 (16.1)	0.56 (0.49, 0.65)	208 (7.5)	612 (22.0)	0.34 (0.29, 0.40)
(Includes partial and total ban in house)						
Last week did you ever ask your visitor to stop smoking?	156 (5.0)	214 (6.8)	0.73 (0.59, 0.90)	371 (13.3)	375 (13.5)	0.99 (0.85, 1.15)
Have you ever asked anyone to stop smoking on public transportation?	461 (14.7)	574 (18.3)	0.80 (0.71, 0.91)	383 (13.7)	606 (21.7)	0.63 (0.55, 0.72)
Have you ever avoided going to a place where you were exposed to smoking?	722 (23.0)	306 (9.8)	1.13 (1.00, 1.28)	463 (16.6)	528 (18.9)	0.88 (0.77, 0.100)

Note. CI = confidence interval; OR = odds ratio.

Table 4. Multivariate Analysis

Category	Predictors	OR (95% CI)
Have you smoked on public transportation? (Respondents include only current and former male smokers)	Control (=0) or intervention (=1)	1.65 (1.20, 2.27)
	Age, continuous	0.96 (0.94, 0.97)
	Marital status ^a	1.14 (0.99, 1.32)
	Highest education achieved ^b	0.98 (0.87, 1.11)
	Do you work? (no = 0; yes = 1)	2.24 (1.03, 4.84)
	Have you smoked 100+ cigarettes? (no = 0; yes = 1)	1.07 (0.15, 1.24)
Model <i>p</i> value: <.0001		
Is there a smoking ban in all or part of your home? (Includes all respondents)	Control (=0) or intervention (=1)	0.89 (0.75, 1.06)
	Age, continuous	1.01 (1.00, 1.02)
	Sex (male = 0; female = 1)	0.30 (0.17, 0.55)
	Marital status ^a	1.22 (1.12, 1.32)
	Highest education achieved ^b	1.28 (1.20, 1.37)
	Do you work? (no = 0; yes = 1)	1.02 (0.77, 1.35)
Model <i>p</i> value: <.0001		
Have you asked someone on public transportation to stop smoking? (Includes all respondents)	Control (=0) or intervention (=1)	1.24 (1.05, 1.46)
	Age, continuous	0.99 (0.99, 1.00)
	Sex (male = 0, female = 1)	1.18 (0.66, 2.11)
	Marital status ^a	1.14 (1.05, 1.24)
	Highest education achieved ^b	1.26 (1.18, 1.34)
	Do you work? (no = 0; yes = 1)	1.16 (0.89, 1.51)
Model <i>p</i> value: <.0001		
Do you avoid exposure to smoking? (Includes all respondents) ^c	Control (=0) or intervention (=1)	1.14 (1.04, 1.24)
	Age, continuous	1.01 (1.00, 1.01)
	Sex (male = 0, female = 1)	3.13 (2.83, 3.45)
	Marital status ^a	1.02 (0.97, 1.06)
	Highest education achieved ^b	1.18 (1.14, 1.22)
	Do you work? (no = 0; yes = 1)	0.76 (0.65, 0.87)
Model <i>p</i> value: <.0001		

Note. CI = confidence interval; OR = odds ratio.

^aMarital status: never married = 1; divorced = 2; widowed = 3; married = 4.

^bHighest education: do not read or write = 0; primary education = 1; preparatory education = 2; secondary education = 3; postsecondary education = 4.

^cWhen the variable "Have you smoked 100+ cigarettes?" was added, smokers from both the control and intervention villages were less likely to avoid exposure to smoking.

variables, targeted at the whole study population, were adjusted for the same factors plus gender. There was no significant difference between the groups in the number who implemented a smoking ban in the home ($p = .205$). There was a significant difference ($p = .011$) in the number who had asked someone on public transportation to stop smoking: intervention respondents were 1.24 times more likely to have asked after the intervention. The last question asked whether respondents avoided exposure to smoking. Again there was a significant difference ($p = .004$) between groups (intervention: 1.14 times more likely). This model adjusted for all of the above factors except smoker status—when included as a predictor variable, the difference disappeared since smokers from neither group avoided other smokers.

Given the changes in smoking behavior, the question arises, why did respondents change their behavior? Two questions in both the pre- and postintervention addressed this issue (data not shown). The first asked, "Why would you quit smoking?" Options included: to improve one's health, to save money, on doctor's advice, and for children's health. Children's health had the most significant increase from pre- to postintervention for both groups: the control group increased from 19.8% to 30.5% ($p = .007$) and the intervention group from 13.7% to 40.7% ($p < .001$). Also in the preintervention period, significantly

more control respondents ($p = .043$) listed children's health as a reason compared to intervention respondents. Postintervention, this trend reversed itself, although not significantly ($p = .128$). The other responses to motivation for quitting were not significantly different between the two groups. The second question asked, "Who advised you to stop smoking?" Of the possible sources (doctors, other health professionals, friends, family, and religious clerics), only "other health professionals" showed a significant increase from pre- to postintervention in both the control (2.0%–24.6%, $p < .001$) and intervention villages (3.7%–38.3%, $p < .001$).

DISCUSSION

This study aimed to alter smoking behavior and attitudes toward smoking in order to reduce ETS exposure for nonsmokers, specifically women and children since most smokers in Egypt are adult males. Our results showed that the study's community-based intervention had an overall positive impact in both aspects of tobacco control. The results also support findings from previous research that community-based education and enforced smoking bans in public areas are effective measures

for reducing ETS exposure. One of the most widely known and successful programs for reducing ETS exposure has been the California Tobacco Program (Bal, Lloyd, Roeseler, & Shimizu, 2001; Rohrbach et al., 2002). The program had multiple components, including the reduction of ETS through local policies and public education programs. Campaigns that focused on encouraging families to restrict smoking in their homes and cars resulted in a significant decrease in the proportion of 10th grade youths who reported being exposed to ETS in the previous week over a 2-year period. In 10 studies reviewed in the U.S. Department of Health and Human Services *Community Guide* (Hopkins et al., 2001; Zaza, Briss and Harris, 2005), all demonstrated a positive effect of clean indoor air regulations, at both the local and state levels, on reduced consumption, lower prevalence of smoking, and increased cessation.

Our intervention demonstrated success in educating respondents about the hazards of smoking and ETS and how to respond. For example, we saw an increase in knowledge: in the questions asking whether participants had received information on the common effects of smoking on children, adults, and pregnant women, the intervention group reported significantly higher rates of affirmative responses than the control group. Our results also showed a greater increase from pre- to postintervention in the number of respondents, particularly those in the intervention group, who recognized that smoking *shisha* is not a safer alternative to cigarettes. This is in alignment with two reports released by the World Health Organization (Mohamed, Loffredo, & Israel, 2006; World Health Organization, 2005). The greatest behavior change was seen in both groups demonstrating a greater ability to ask smokers to stop smoking and to implement total or partial smoking bans in the home.

Regarding smokers, the results of our study support the evidence (Fiore et al., 2008; Lancaster, Stead, Silagy, & Sowden, 2000) that changes in smokers' behaviors are difficult to achieve, as these behaviors become entrenched through the addictive components in tobacco and the social rituals surrounding the act of smoking. This study found that neither the control nor intervention group showed any changes in the number of current smokers or in rates for quitting during the study's time period. This might be attributed to the lack of smoking cessation clinics offering professional help to smokers who wanted to quit. The exception to this trend was *shisha* smoking. While the control group showed no change in this respect, the intervention group was 2 times more likely to have smoked *shisha* in the last month before the intervention than in the follow-up.

Study Strengths and Limitations

Regarding strengths of this study, the design for randomization and recruitment proved very successful. The randomization process reduced selection bias and yielded groups with very similar baseline data. The recruitment process had high overall participation/retention rates and the same retention rate in each group, another indication of parity. Regarding intervention implementation, all activities in the five prongs were carried out by locals, trained and supervised by our teams, in order to foster a sense of intervention ownership. This study followed the intention-to-treat analysis by including all randomized subjects in the analysis regardless of their self-reported participation in any of the intervention activities. The data analysis approach to the paired data pre- and postintervention produced a highly efficient statistical analysis; allowing the measurement

of differences in behavior between groups when adjusted for potential confounders in the pairwise multivariate analysis.

In terms of the limitations of this study, several methodological issues should be considered in evaluating the results. One of the weaknesses was our resource-intensive (both financially and personnel wise) approach that simultaneously targeted elementary schools, preparatory and secondary schools, youth clubs, mosques, homes, and primary health care clinics, with the intention of reaching all members of the community. This study was not designed to identify which of the prongs was the most effective in changing knowledge, behavior, and attitudes, but rather to assess the effectiveness of the entire campaign. A smaller scale, more targeted method (e.g., a household visit) might have been equally effective and reached most members of the community. Such an approach would be applicable to similar lower income societies. Also, many of the knowledge-gain questions were only asked in the postintervention survey, so change could not be measured. Finally, a second follow-up survey administered at a certain interval of time following the intervention would have provided information on the long-term effectiveness of the intervention's message on the hazards of smoking and ETS exposure. However, such a survey was not within the scope of the original study proposal and no such survey is currently planned.

While improvements in a control group are not uncommon, the exact reason in this study is difficult to pinpoint. It is not clear whether these positive gains are attributable to efforts by the Ministry of Health in Egypt regarding tobacco control during this period, to tobacco-related health information publicly available from outside sources such as the television or the Internet, or to a spillover of information from neighboring intervention villages. Although villages were spaced at least 10 miles apart in order to avoid between-village influences, that distance may have been inadequate, allowing participants in the control group to learn about our intervention activities. Further research on sources regarding smoking hazards in Egypt could shed light on this question.

CONCLUSIONS

In conclusion, while the intervention did not lead to a decrease in smokers, it did modify where smokers smoked and increase nonsmokers' advocacy for their and their families' health. It also increased the overall knowledge about the hazards of smoking and ETS. Such improvements suggest that community interventions have great potential to advance and augment existing efforts in tobacco control in rural Egypt and in other low income, rural countries. Further research is needed, however, to streamline this intensive intervention and to make it more affordable and sustainable in such settings. One approach would be to concentrate on the social change agents. A focus group study followed up with former intervention participants and asked which of the prongs was most effective (Jillson, 2007). The vast majority cited the home visits. This finding is especially important in other culturally similar regions in the Middle East and North Africa, where social change agents have already been effective in promoting behaviors related to reproductive and child health and avian influenza prevention and where many women do not work outside the home. Reaching these women can be difficult through other channels, yet they can have major impacts on changing smoking behaviors and improving attitudes in the home toward positive health

changes, as our study and others have indicated (Chan, Leung, Wong, & Lam, 2008). Furthermore, the success of social change agents in ETS prevention could be replicated in other populations such as minority communities in the United States or migrant communities in European Union countries where language, traditions and customs, socioeconomics, and access to education are barriers to accessing health care information and services.

FUNDING

This work was supported by The Fogarty International Center of the U.S. National Institutes of Health (R01TW059444).

DECLARATION OF INTERESTS

None declared.

ACKNOWLEDGMENTS

The authors acknowledge the central role of the late Dr. Mostafa Kamel Mohamed of Ain Shams University, who led the Egypt Smoking Prevention Research Initiative and worked tirelessly for tobacco control in the entire region.

REFERENCES

- Bal, D. G., Lloyd, J. C., Roeseler, A., & Shimizu, R. (2001). California as a model. *Journal of Clinical Oncology*, 19, 69s–73s. Retrieved from http://jco.ascopubs.org/content/19/suppl_1/69s.full
- Chan, S. S., Leung, G. M., Wong, D. C., & Lam, T. H. (2008). Helping Chinese fathers quit smoking through educating their nonsmoking spouses: A randomized controlled trial. *American Journal of Health Promotion*, 23, 31–34. doi:10.4278/ajhp.07043040
- Environmental Protection Agency. (2011). Health effects of exposure to secondhand smoke. Washington, DC: Author. Retrieved from www.epa.gov/smokefree/healtheffects.html
- Fiore, F. C., Jaén, C. R., Baker, T. B., Bailey, W. C., Benowitz, N. L., & Curry, S. J. (2008). Treating tobacco use and dependence: 2008 update—clinical practice guideline. Washington, DC: U.S. Department of Health and Human Services. Retrieved from www.hhs.gov/
- Gharaibeh, H., Haddad, L., Alzyoud, S., El-Shahawy, O., Abu Baker, N., & Umlauf, M. (2011). Knowledge, attitudes, and behavior in avoiding secondhand smoke exposure among non-smoking employed women with higher education in Jordan. *International Journal of Environmental Research and Public Health*, 8, 4207–4219. doi:10.3390/ijerph8114207
- Hopkins, D. P., Briss, P. A., Ricard, C. J., Husten, C. G., Carande-Kulis, V. G., Fielding, J. E., . . . Task Force on Community Preventive Services. (2001). Reviews of evidence regarding interventions to reduce tobacco use and exposure to environmental tobacco smoke. *American Journal of Preventive Medicine*, 20, 16–66. Retrieved from www.elsevier.com/locate/amepre
- Hurt, R. D., Weston, S. A., Ebbert, J. O., McNallan, S. M., Croghan, I. T., Schroeder, D. R., & Roger, V. R. (2012). Myocardial infarction and sudden cardiac death in Olmsted County, Minnesota, before and after smoke-free workplace laws. *Archives of Internal Medicine*, 29, 1–7. doi:10.1001/2013.jamainternmed.46
- Jillson, I. (2007). Engagement of social change agents in improving women's health in the Arab Republic of Egypt: Developing a framework for evaluation and research. Washington, DC: World Bank. Retrieved from www.worldbank.org/
- Khader, Y. S., Al-Akour, N., AlZubi, I. M., & Lataifeh, I. (2010). The association between second hand smoke and low birth weight and preterm delivery. *Maternal and Child Health Journal*, 15, 453–459. doi:10.1007/s10995-010-0599-2
- Lancaster, T., Stead, L., Silagy, C., & Sowden, A. (2000). Effectiveness of interventions to help people stop smoking: Findings from the Cochrane Library. *BMJ*, 321, 355–358. doi:10.1136/bmj.321.7257.355
- Mohamed, M. K., Loffredo, C. A., & Israel, E. (2006). Tobacco use in shisha: Studies on waterpipe smoking in Egypt. Cairo, Egypt: World Health Organization Regional Office for the Eastern Mediterranean. Retrieved from www.emro.who.int/
- National Cancer Institute and State of California. (1999). Health effects of exposure to environmental tobacco smoke. Bethesda, MD: National Cancer Institute. Retrieved from www.cancer.gov/
- Öberg, M., Jaakkola, M. S., Woodward, A., Peruga, A., & Prüss-Ustün, A. (2011). Worldwide burden of disease from exposure to second-hand smoke: A retrospective analysis of data from 192 countries. *Lancet*, 377, 139–146. doi:10.1016/S0140
- Radwan, G. N., Loffredo, C. A., Aziz, R., Abdel-Aziz, N., & Labib, N., (2012). Implementation, barriers and challenges of smoke-free policies in hospitals in Egypt. *BMC Research Notes*, 5, 568. doi:10.1186/1756-0500-5-568
- Rohrbach, L. A., Howard-Pitney, B., Unger, J. B., Dent, C. W., Howard, K. A., Cruz, T. B., . . . Johnson, C. A. (2002). Independent evaluation of the California tobacco control program: Relationships between program exposure and outcomes, 1996–1998. *American Journal of Public Health*, 92, 975–983. doi:10.2105/AJPH.92.6.975
- Tan, C. E., & Glantz, S. A. (2012). Association between smoke-free legislation and hospitalizations for cardiac, cerebrovascular, and respiratory diseases: A meta-analysis. *Circulation*, 126, 2177–2183. doi:10.1161/CIRCULATIONAHA.112.121301
- U.S. Department of Health and Human Services. (2006). The health consequences of involuntary exposure to tobacco smoke: A report of the surgeon general. Washington, DC: Author. Retrieved from www.hhs.gov/
- Wadi, M., & Al-Sharbatti, S. S. (2011). Relationship between birth weight and domestic maternal passive smoking exposure. *EMHJ*, 17. Retrieved from www.emro.who.int/emh-journal/eastern-mediterranean-health-journal/home.html
- World Health Organization. (2005). Waterpipe tobacco smoking: Health effects, research needs, and recommended actions by regulators. Geneva: Author. Retrieved from www.who.int/en/
- World Health Organization. (2011a). Tobacco: Fact sheet no. 339. Geneva: Author. Retrieved from www.who.int/en/
- World Health Organization. (2011b). Frequently asked questions about second hand smoke. Geneva: Author. Retrieved from www.who.int/en/
- World Health Organization Regional Office for the Eastern Mediterranean. (2010a). Global adult tobacco survey: Egypt fact sheet. Cairo, Egypt: Author. Retrieved from www.emro.who.int/
- World Health Organization Regional Office for the Eastern Mediterranean. (2010b). Global adult tobacco survey: Egypt country report 2009. Cairo, Egypt: Author. Retrieved from www.emro.who.int/
- Zaza, S., Briss, P. A., & Harris, P. A. (2005). The guide to community preventive services: What works to promote health? New York, NY: Oxford University Press. Retrieved from <http://ukcatalogue.oup.com/>