


Effectiveness of a School-Based Tobacco Prevention Program for Middle School Students in Saudi Arabia: A Quasi-Experimental Controlled Trial

Tobacco Use Insights
Volume 13: 1–9
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DOI: 10.1177/1179173X20953403



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ABSTRACT

OBJECTIVE: To evaluate the effect of a school-based tobacco program in preventing initiation of tobacco use among adolescents in Saudi Arabia.

METHODS: We used a quasi-experimental controlled design. Four intervention and four control schools were selected from the regional education registry. A baseline questionnaire was administered to all grade 7 students before implementing the tobacco prevention program, Dentists Fighting Nicotine Dependence (DFND). The intervention group ($n = 379$) received the DFND program whereas the control group ($n = 255$) received the regular tobacco program administered by the Department of Education. The program was delivered by trained health educators over 5 weeks. Pre- and post-test surveys (immediate and 2-year post-intervention) were collected. Study outcomes were current tobacco use, tobacco knowledge, attitude towards not using tobacco, and perceived behavioral control (PBC) of tobacco use. Covariates included sex, parent education, academic performance, absenteeism, student allowance, and religiosity. Data were analyzed using a two-level hierarchical mixed models.

RESULTS: In the immediate post-test, 597 participants (intervention, $n = 366$; control, $n = 231$) were surveyed. There was no difference in tobacco use between intervention and control schools, however, the intervention group had significantly higher mean scores for knowledge ($\beta = 1.27$, $SE = 0.27$, $P < .01$) and attitude toward not using tobacco ($\beta = 5.17$, $SE = 2.48$, $P < .05$) after adjusting for covariates. At 2-year post-intervention, 463 participants (intervention, $n = 289$; control, $n = 173$) were surveyed. There were no differences in tobacco use, knowledge, attitude or PBC between intervention and control groups.

CONCLUSIONS: Our program did not impact tobacco use. In the short-term, the program significantly improved knowledge and attitude towards not using tobacco. These effects decayed 2 years post-intervention without additional programming. Increasing the effectiveness of DFND may be achieved by expanding curriculum content and practice time throughout the school years and by targeting high-risk adolescents within the program.

KEYWORDS: Tobacco, smoking prevention, intervention, adolescent, schools, Saudi Arabia

RECEIVED: December 19, 2019. **ACCEPTED:** August 3, 2020.

TYPE: Original Research

FUNDING: The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The study was funded by a grant from King Abdulaziz University Deanship of Scientific Research [Grant No. 554/254/1432].

DECLARATION OF CONFLICTING INTERESTS: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Introduction

Tobacco use is the leading cause of preventable death worldwide. The World Health Organization (WHO) defines premature death due to tobacco use as a global epidemic.¹ The Centers for Disease Control (CDC) estimate that 5.4 million people die each year from tobacco-related causes.² This estimate is expected to rise to 8 million by 2030, if current global trends in tobacco use persist.³ While major health consequences of tobacco use are usually not evident until adulthood, most (88%) first use of cigarettes occurs by 18 years of age.³ Adolescents and young adults are especially vulnerable to tobacco use and the initiation of tobacco use.³ People who start tobacco use at an early age are more likely to develop severe levels of nicotine addiction and are more likely to use more than one tobacco product than those who start at a later age.⁴ Thus, prevention of uptake of tobacco and early cessation

among youth is one of the primary goals of tobacco control and prevention.⁵

Worldwide, about one in four adolescents aged 13–15 years have ever smoked a cigarette and at least 1 in 10 are current tobacco users. The proportion of those who have ever smoked a cigarette is higher among boys (34.2%) compared to girls (18.2%).⁶ The use of multiple tobacco products is prevalent among adolescents with the highest prevalence observed in the Eastern Mediterranean (EMRO) region of the World Health Organization (WHO).⁷ The most recent (2010) Global Youth Tobacco Survey (GYTS) for Saudi Arabia reported that 24.9% of youth aged 13–15 had ever smoked cigarettes and 14.9% currently use tobacco products. Specifically, 8.9% smoked cigarette, 9.5% smoked shisha, and 11.0% used another form of tobacco.⁸ Higher rates are projected for 2025, if the country maintains its tobacco control efforts at the same level.⁷



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Schools are considered an ideal venue for adolescent tobacco prevention interventions.⁹ Interventions to prevent initiation of tobacco use among youth have employed a variety of models including information-based, social competence, social influence, combined social competence and influence, and multimodal programs.⁹ A systematic review of school-based smoking prevention studies concluded that information-only interventions were ineffective in preventing smoking whereas interventions that used social influence approaches found significant positive results although there was no evidence of a long-term effect on smoking prevalence.⁹ Other reviews and meta-analyses suggested that school-based smoking prevention programs can have significant long-term effects if they are interactive and based on social influences or social skills models, are peer-led, have community components, are focused on intentions not to use tobacco, have many sessions that continue for multiple years, and have produced considerable short-term effects.^{10,11} The Centers for Disease Control and Prevention (CDC) continues to recommend implementing school-based prevention in coordination with other community-wide approaches such as increasing the unit price of tobacco products, sustaining anti-tobacco media campaigns, and making environments smoke-free.¹²

The current school-based tobacco prevention program supported by the Department of Education in Saudi Arabia is information-based only. The program consists mainly of a video and an accompanying instruction manual to guide teachers on key discussion points with the students. The video is usually shown by a science teacher or a counselor over 1-2 class periods. Other supplemental materials such as a magazine for students, a pamphlet for parents, and a poster for the school are distributed depending on availability. The program, however, is not implemented on a regular basis, covers only up to 60% of schools, offered only to male students since schools are segregated by sex, and has never been evaluated.

Although the current rate of tobacco use is higher in male youth compared to females,⁸ the vulnerability of adolescent females to nicotine use is higher.¹³ Compared to male adolescents, female adolescents are more likely to initiate smoking and are less likely to give it up. They are also more likely to report higher levels of stress and depression during nicotine abstinence. Developing a school-based tobacco prevention program that is directed at Arab male and female adolescents, addresses tobacco knowledge, social competence and social influence, and delivered in multiple sessions by trained health educators, is critical to combat the rising tobacco rates in the country.

The purpose of this study was to evaluate a school-based tobacco prevention program to prevent the initiation of tobacco use among male and female middle school students in Jeddah, Saudi Arabia, using a combined social competence and influence curriculum.

Methods

Study design

A quasi-experimental matched pair design was utilized to evaluate the effectiveness of a pilot study of a school-based tobacco program, "Dentists Fighting Nicotine Dependence (DFND)," to prevent the initiation of tobacco use among middle school students in Jeddah, Saudi Arabia. The intervention focused on 7th graders who were followed and surveyed 2 years after the intervention.

Oral health professionals are trained in the diagnosis, treatment, and prevention of oral health diseases and conditions. Because of their training, expertise, and authority, they are well-equipped to educate students about the importance of not using tobacco, a causal factor of several oral health diseases.⁴

Sample selection

The study targeted middle schools located in the South and East of Jeddah since these regions have higher rates of tobacco use among students compared to schools located in the North and West.¹⁴ Eight schools (four males and four females) were selected by the regional directors of education from the regional registry of middle schools in the South and East of Jeddah; four served as intervention and four as control.

We faced an issue when it came to selecting schools for the intervention program. The regional directors argued that the majority of school principals would not accept a 12-hour intervention program (including pre- and post-test surveys). We were strongly advised to have the schools selected by them if we wanted to keep our tobacco intervention program length and breadth as planned. We felt that cutting our program was not an option, and as such we decided to work with the schools that they personally recommended for allowing us to run our full program and study. To manage the situation to the best of our ability, we asked the regional directors for both male and female schools to also consider in the selection of the schools that they be as similar as possible to each other in geographic location, students' culture, and socioeconomic indicators.

The intervention schools were located at least 6 km (about 15 minutes' drive) away from the control schools. Three to four 7th grade classes were randomly selected from each school, yielding a total of 28; 14 served as intervention and 14 as control. The age of students in these classes ranged from 12 to 13. All of the students who were present in these classes at the initial visit were invited to participate in the study. The total sample at baseline was 634; 379 intervention and 255 control participants.

The intervention schools received only the new tobacco prevention program (DFND) whereas the control schools received the regular Department of Education anti-smoking materials. Since these materials are offered to male students only at the time of study, we requested and confirmed that they were offered to the 7th grade female students in the two

control schools, according to the study plan. The study commenced in mid-February of 2012 and ended in April of 2014.

The intervention program

The DFND program consisted primarily of a 10-session curriculum, each session lasting about an hour. The curriculum was broad and incorporated information about tobacco, consequences of tobacco use, social influences, and social competence skills.

Training of program instructors. The sessions were led by newly graduating dentists who attended a 3-day training workshop on the content and delivery of the curriculum to increase implementation fidelity. They were trained by the program developer on the content of the curriculum and by a certified trainer in communication skills who was also a former director of education for the South Region in Jeddah. On the 3rd day of the workshop, each instructor presented a part of the intended curriculum and received individual feedback on the program content and presentation skills. The planned lessons were reviewed before each week of delivery. A total of 16 instructors were trained to administer the program; every two instructors were paired to co-teach the entire curriculum to one class.

Implementation of intervention program at schools. Beginning in mid-February of 2012, the instructors met with the students and administered the pre-test survey and thereafter met the same students twice a week for five continuous weeks to deliver the curriculum. The curriculum's content and timing of administration were the same for all intervention classes. PowerPoint presentations, videos, role plays, and discussion were used in delivering the curriculum. Information about the availability of anti-smoking clinics were provided in a PowerPoint slide at the end of every lesson. These clinics are provided by the Ministry of Health and offer free consultation and preventive services for individuals of all ages who intend to quit smoking. In addition, an educational booklet on tobacco (in full color) was distributed to students on the first week of the program. To engage the parents/caregivers at home and inform them about the program, we sent out four newsletters with the students, one newsletter every week. To engage the whole school and provide a supportive environment at the school, twenty short anti-tobacco announcements were prepared and a protocol for their delivery was given to the school administrators. They were asked to broadcast one anti-tobacco message per day during morning assembly while the program was active in their school. The students were also encouraged to participate in a poster contest to portray the adverse effects of tobacco use which took place at the completion of the curriculum.

Implementation fidelity. To evaluate if program implementation instructions were clearly followed, two surveys for students and parents were administered at the end of the program. The

students were asked about the implementation of specific intervention components. They were also asked to rate whether each component have helped them understand the topic. In addition, the program instructors and several school teachers and administrators were informally interviewed by the program developer to assess their views on the program and overall adherence to implementation of the curriculum (lectures, videos, instructors), school tobacco broadcast, and other components of the program.

Pre-post test surveys

The 7th grade students in both intervention and control schools completed a baseline pretest self-administered questionnaire proctored by the trained instructors in their classrooms one week prior to the commencement of the program. The students were informed that the information collected in the survey was strictly confidential and the teachers and other school personnel were not allowed to enter the classrooms while surveys were being administered. The questionnaire took approximately half an hour to complete. The questionnaire was designed in English then translated into Arabic and the translation fidelity was established through a back-translation method. The intervention was followed by two post-intervention questionnaires, the first was administered 1 week after the intervention and the second 2 years later, when the students were in grade 9.

The questionnaires collected data on students' sociodemographic characteristics, current tobacco use, knowledge about tobacco, as well as students' social norms, attitudes toward tobacco use, perceived behavioral control (PBC) of tobacco use, and future intention to use tobacco. We followed the theory of planned behavior (TPB) in developing our questionnaire to assess behavioral, normative, and control beliefs that affect behaviors and behavioral intentions.^{15,16} Validated measures to assess TPB were used.¹⁷ We modified few adjectives because they were difficult to interpret for adolescents after translating them into Arabic. Measures of other study variables such as absenteeism, academic performance, or religiosity were developed based on a general review of the literature and team expertise. These data were entered into a Microsoft Access database and subsequently converted into SAS (version 9.4) for analysis.

Study measures

Sociodemographic characteristics and school-related factors. Data on student's age, sex, school daily allowance, academic performance in previous year, absenteeism, religiosity, and parents' level of education were collected. For analytical purposes, parents' education was coded as < high school diploma, high school diploma, and > high school diploma. Academic performance in the previous year was coded as follows: 3, if student's work consistently met grade level expectations; 2, if progress has been made but there is room for improvement; or 1, if there was a reason for

concern. Absenteeism was assessed by asking students about their rate of skipping classes in a typical term; never, occasionally, sometimes, or most times. Absenteeism was coded as not relevant if a student reported “never” or “occasionally” and relevant if otherwise. Religiosity was scored on a 5-point scale, 5 being very religious and 1 not religious at all. It was recoded as religious if a student’s score was 5 or 4 and not religious otherwise.

Primary and secondary outcome measures. Self-reported use of any tobacco products at the time of the survey, our primary outcome, was assessed using a dichotomous, yes/no question, “Do you currently use any form of tobacco?” Current use of tobacco was explained to students as their use of any tobacco products in the past 30 days.

Secondary outcome measures were knowledge, attitudes, and PBC. The student’s knowledge and awareness about tobacco use was assessed by asking 15 true/false questions. For example, “Smoking is harmful only if you smoke for a long time—20–30 years or more.” A high score was indicative of knowledge about tobacco and awareness of its adverse health effects. Attitude is the degree to which an individual has a favorable or unfavorable evaluation of a behavior.

Direct attitude towards ‘not to use tobacco’ was measured with three items using a five-point bipolar scale; “For me, not to use tobacco is” unpleasant (1)/pleasant (5), bad (1)/good (5), and worthless (1)/valuable (5). Higher scores represented a positive attitude toward “not to use tobacco.” Reliability was confirmed using Cronbach’s alpha ($\alpha = 0.63$). The belief measure of attitude (indirect attitude), behavioral beliefs and corresponding outcome evaluation were developed from a previous study.¹⁸ The behavioral beliefs were measured with five items based on a 5-point scale ranging from 1 (very unlikely) to 5 (very likely). The corresponding five outcome evaluation items were assessed on a 5-point scale ranging from 1 (extremely bad) to 5 (extremely good). Each behavioral belief item score was multiplied by its corresponding outcome evaluation and the products were summed for a weighted belief score. The higher the score, the more favorable the behavioral belief is toward “not to use tobacco.”

PBC is the perception of how easy or difficult it is for one to perform the behavior. PBC was measured using six items rated on a 5-point bipolar scale: “For me not to use tobacco is very difficult (1)/very easy (5);” “For me not to use tobacco is impossible (1)/possible (5);” “I am confident that I will not use tobacco,” ranging from (1) strongly disagree to (5) strongly agree; “There is very little I can do to make sure that I do not use tobacco,” rated on a scale from 1 (true) to 5 (false); “It is entirely up to me not to use tobacco in the future,” rated on a scale from 1 (strongly disagree) to 5 (strongly agree); “How much control do you have over not to use tobacco?,” rated on a scale from (1) absolutely no control to (5) complete control. The higher the PBC score the greater the sense of control over not using tobacco. Reliability was confirmed using Cronbach’s alpha ($\alpha = 0.60$).

Intention to use tobacco. Students’ intention to use tobacco in the future was assessed by asking them to respond to the statement “I intend to use tobacco in the future” in the pre- and post-test surveys. Responses were selected on a scale which ranged from 1, strongly disagree, to 5, strongly agree.

Statistical analysis

Descriptive statistics in the form of frequencies and means were generated for all study variables. To compare the intervention and control groups across a range of measures, we utilized paired sample *t*-test for continuous variables, chi-square test for categorical variables, and Wilcoxon Rank Sum Test, also known as the Mann-Whitney U test for discreet or skewed distributions (eg, knowledge and attitude).

We analyzed the data using a mixed modeling approach. A mixed model is a statistical model containing both fixed and random effects. To this end, we applied the proc mixed for continuous, discreet, or outcomes on a Likert scale and proc Glimmix for binary or categorical outcomes in the SAS (Statistical Analysis System) software. We modeled the study outcomes of individual students (level 1) while simultaneously assessing the influence of the schools that the participating students attended (at level 2). All tests of hypothesis were two-tailed with a type 1 error rate set at 5%.

Ethical issues

The study was registered in ClinicalTrials.gov as a retrospective trial and the identifier number is: NCT03579355. The protocol of this study was approved by the Ethics Committee of the Deanship of Scientific Research at King Abdulaziz University, Jeddah, Saudi Arabia. A written study approval was also obtained from the Director of the Department of Education in Jeddah and verbal consent was obtained from the participating students. The requirement for parental consent was waived by the Ethics Committee.

Results

The program was implemented in all four intervention schools according to the study’s protocol with one exception, the announcements of the anti-tobacco messages. Each school had its own approach and preference in delivering them. Some broadcasted all anti-tobacco messages in one session, others announced them over few days only. Some broadcasted them during assembly and some in the students’ break time.

The sample size at the beginning of study was 634 comprising 379 in the intervention group and 255 in the control group respectively. The baseline descriptive statistics of students in the intervention and control groups were similar except for sex, where the control group had a larger proportion of female students compared to male students (65.9% vs 34.1%, $P < .01$; Table 1).

Table 1. Baseline descriptive statistics of participants in intervention and control schools (n = 634).

CATEGORICAL VARIABLES	INTERVENTION (N = 379)	CONTROL (N = 255)	P-VALUE
	FREQUENCY (%)	FREQUENCY (%)	
Gender			
Male	176 (46.44)	87 (34.12)	.002 ^{a*}
Female	203 (53.56)	168 (65.88)	
Parent education			
< High school	197 (51.98)	112 (43.92)	.23 ^a
High school	72 (19.00)	54 (21.18)	
> High school	71 (18.73)	60 (23.53)	
DK	39 (10.29)	29 (11.37)	
Academic			
Performance	326 (86.02)	214 (83.92)	.10 ^a
3	40 (10.55)	23 (9.02)	
2	13 (3.43)	18 (7.06)	
1			
Absenteeism			
No	271 (71.50)	198 (77.65)	.08 ^a
Yes	108 (28.50)	57 (22.35)	
Religiosity			
Not-religious	160 (42.22)	123 (48.24)	.13 ^a
Religious	219 (57.78)	132 (51.76)	
Tobacco use			
No	346 (91.29)	241 (94.51)	.13 ^a
Yes	33 (8.71)	14 (5.49)	
OTHER VARIABLES	MEAN (SD)	MEAN (SD)	P-VALUE
Age	13.29 (0.88)	13.32 (0.86)	.63 ^b
Student allowance	4.00 (1.61)	4.22 (1.87)	.13 ^b
Knowledge	9.06 (1.83)	9.11(1.54)	.71 ^c
Direct attitude	13.07 (2.73)	13.41 (2.39)	.10 ^c
Indirect attitude	114.1 (21.73)	112.6 (22.03)	.43 ^c
PBC	24.17 (4.81)	24.15 (4.71)	.94 ^c

Abbreviations: PBC, perceived behavioral control; Academic performance, 3 = meets expectations, 2 = progress, 1 = reason for concern; SD, standard deviation; DK, do not know.

^a χ^2 test of significance; ^bt-test of significance; ^cWilcoxon Rank Sum Test (Mann-Whitney U test) of significance.

*P is significant.

Immediate effects of the tobacco prevention program

A total of 597 (intervention: n = 366, control: n = 231) students completed the immediate post-test survey, representing 94.2% of the original sample.

Primary outcome: Tobacco use

The prevalence of current tobacco use at 1-week post-intervention survey was 5.7% and 4.3% in intervention and control groups, respectively. Tables 2 and 3 show the immediate effects

Table 2. Unadjusted immediate post-intervention results of school tobacco prevention program on primary and secondary outcome measures (n = 597).

VARIABLE	INTERVENTION (N = 366)	CONTROL (N = 231)	P-VALUE
	% OR MEAN (SD)	% OR MEAN (SD)	
Primary outcome measure			
Tobacco use (yes)	5.74%	4.33%	.45 ^a
Secondary outcome measure			
Knowledge	10.64 (1.87)	9.28 (1.77)	<.0001 ^{b*}
Direct attitude	13.69 (2.35)	13.35 (2.67)	.11 ^b
Indirect attitude	119.4 (30.10)	114.3 (28.81)	.04 ^{b*}
PBC	24.93 (4.96)	24.68 (5.07)	.54 ^b

Abbreviations: PBC, perceived behavioral control; SD, standard deviation.

^a χ^2 test of significance; ^bWilcoxon Rank Sum Test (Mann-Whitney U) of significance.

*P is significant.

Table 3. Multi-level analyses of immediate post-test effects of school tobacco prevention program on primary and secondary outcome measures (n = 597).

VARIABLE	KNOWLEDGE	DIRECT ATTITUDES	INDIRECT ATTITUDES	PBC	TOBACCO USE
	ESTIMATE (SE)	ESTIMATE (SE)	ESTIMATE (SE)	ESTIMATE (SE)	OR (95% CI)
Group					
Intervention	1.27 (0.27)*	0.27 (0.20)	5.17 (2.48)**	0.17 (0.42)	1.51 (0.66-3.42)
Control	0	0	0	0	1.00
Gender					
Male	0.47 (0.27)	-0.05 (0.20)	-4.67 (2.49)	-0.12 (0.42)	1.46 (0.67-3.17)
Female	0	0	0	0	1.00

Adjusted for parent education, academic performance, absenteeism, allowance, and religiosity.

Abbreviations: PBC, perceived behavioral control; SD, standard deviation; OR, adjusted odds ratio; CI, confidence intervals.* $P < .01$; ** $P < .05$.

of the tobacco prevention program on current tobacco use before and after adjusting for covariates, respectively. There was no significant difference in current tobacco use between the intervention and control groups in the unadjusted or adjusted analysis.

Secondary outcomes: Knowledge, attitude, and PBC

The results of the unadjusted analysis are shown in Table 2. The students in the intervention group had significantly higher mean scores for knowledge about tobacco compared to those in the control group ($\bar{x} = 10.64$, $SD = 1.87$, range = 3-15 vs $\bar{x} = 9.28$, $SD = 1.77$, range = 5-13, $P < .0001$). Similarly, they had higher mean scores for indirect attitude toward not using tobacco ($\bar{x} = 119.4$, $SD = 30.1$, range = 11-175, vs $\bar{x} = 114.3$, $SD = 28.81$, range = 11-175, $P < .05$). There were no significant differences between the groups with respect to direct attitude or PBC.

The improvement in knowledge and indirect attitude toward not using tobacco in the intervention group was still significant after adjusting for sex, parent education, academic

performance, absenteeism, student allowance, and religiosity in the adjusted analysis (Table 3). Compared to their counterparts in the control group, students who were exposed to the intervention achieved about 1.3 points higher mean scores for knowledge about tobacco ($\beta = 1.27$, $SE = 0.27$, $P < .01$) and 5.2 points higher mean scores for indirect attitude toward not to use tobacco ($\beta = 5.17$, $SE = 2.48$, $P < .05$).

Intention to use tobacco

The P -value for the intention to use tobacco in the future between the intervention and control groups in the immediate post-test survey was not significant ($P = .28$).

Two-year post-intervention effects of the tobacco prevention program

A total of 463 (intervention: $n = 289$, control: $n = 173$) students completed the 2-year post-test survey, representing 73% of the original sample.

Table 4. Unadjusted 2-year post-intervention results of school tobacco prevention program on primary and secondary outcome measures (n = 463).

VARIABLE	INTERVENTION (N = 289)	CONTROL (N = 173)	P-VALUE
	% OR MEAN (SD)	% OR MEAN (SD)	
Primary outcome measure			
Tobacco use (yes)	14.53	9.25	1.00
Secondary outcome measure			
Knowledge	10.50 (1.66)	10.37 (1.42)	0.38
Direct attitude	14.05 (1.87)	14.06 (1.87)	1.00
Indirect attitude	101.9 (25.04)	99.72 (22.11)	0.35
PBC	25.0 (3.96)	24.88 (3.47)	0.73

Abbreviations: PBC, perceived behavioral control; SD, standard deviation.
^aχ² test of significance; ^bWilcoxon rank sum test (Mann-Whitney U) of significance.

Table 5. Multi-level analyses of 2-year post-test effects of school tobacco prevention program on primary and secondary outcome measures (n = 458).

VARIABLE	KNOWLEDGE	DIRECT ATTITUDE	INDIRECT ATTITUDE	PBC	TOBACCO USE
	ESTIMATE (SE)	ESTIMATE (SE)	ESTIMATE (SE)	ESTIMATE (SE)	OR (95% CI)
Group					
Intervention	0.12 (0.15)	-0.06 (0.18)	2.20 (2.83)	0.01 (0.40)	1.56 (0.51-4.71)
Control	0	0	0	0	[1.00]
Gender					
Male	0.35 (0.16)**	0.49 (0.19)*	4.78 (2.89)	1.32 (0.41)**	0.46 (0.15-1.43)
Female	0	0	0	0	[1.00]

Adjusted for parent education, academic performance, absenteeism, allowance, and religiosity.
 Abbreviations: PBC, perceived behavioral control; SD, standard deviation; OR, adjusted odds ratio; CI, confidence intervals.**P* < .01; ***P* < .05.

Primary outcome: Tobacco use. About 14.5% of students in the intervention group and 9.3% of students in the control group reported using tobacco at the time of the second post-test survey and the difference between them was not statistically significant (*P* > .05).

Secondary outcomes: Knowledge, attitude, and PBC. There were no differences between the intervention and control groups at 2-year post-intervention in all secondary outcomes in the unadjusted (Table 4) or adjusted analyses (Table 5).

The mean scores for knowledge about tobacco ($\beta = 0.35$, SE = 0.16, *P* < .05), direct attitude toward not using tobacco ($\beta = 0.49$, SE = 0.19, *P* < .01), and PBC of tobacco use ($\beta = 1.32$, SE = 0.41, *P* < .05) were consistently higher among male adolescents compared to females.

Intention to use tobacco

In the 2-year post-test survey, there was some evidence of changes in future intention to use tobacco, however, the change in intention did not reach statistical significance (*P* = .09).

Discussion

This study examined primarily the effectiveness of a school-based tobacco prevention program (DFND) based on social competence and influence approaches on tobacco use among middle school students. We observed that the program was effective in the short-term in raising students’ knowledge and awareness of the physical and social consequences of tobacco use and in enhancing their attitudes toward “not to use tobacco.” However, the intervention did not show effectiveness in reducing the prevalence of tobacco use. Further, the effects of the program on knowledge and attitudes decayed after 2 years following the delivery of the program.

Our findings are consistent with those of other investigators. Hwang and colleagues in a meta-analysis of adolescent psychosocial smoking prevention programs reported smaller program effects on smoking behavior, knowledge, and attitudes at longer follow ups without additional programming or booster sessions.¹⁸ They found that knowledge effects increase instantly but decay significantly by 1-year follow-up, and attitudes decay to about half their original effect size by 1-year follow-up.¹⁰ It appears that our program was not long or broad

enough to affect tobacco use and to produce long-term effects in students' knowledge and attitudes. Flay, in a critical review of reviews, concluded that school-based tobacco prevention programs can have substantial long-term effects if they included at least 15 sessions and continued for multiple years.¹¹

Although our program was ineffective in changing behavior, that is, reducing tobacco use, there is a weak evidence of change in intention of future use of tobacco in the 2-year post-test survey ($P = 0.09$). This result supports the fact that behavior change takes time. In order to shift social norms and develop supportive tobacco free environments, repetition across middle and high school years and sustained multi-level educational activities and behavioral skills are critical.¹⁹ In addition, smoking relapse after successful quitting is also higher among younger adults and youth and among those who do not receive treatment and have a friend who smokes. Therefore, tobacco control efforts among adolescents require a combination of close follow up, behavioral support, and pharmacological therapy.^{20,21} Maintaining a tobacco free youth is the ultimate positive outcome of any tobacco use prevention and cessation program.

Interestingly, at 2-year post-intervention, male adolescents consistently displayed better knowledge about tobacco, unfavorable attitude toward tobacco use, and improved PBC of tobacco use compared to females. This is possibly a reflection of the fact that school-based tobacco health education is only offered to male students in Saudi Arabia. Previous studies of Saudi adolescents' smoking behavior regularly reported that females had significantly more favorable attitudes and feelings toward smoking. These studies have also found that more male than female adolescents receive tobacco education and parental guidance and support.^{18,22} Positive perceptions of tobacco use combined with the absence of effective tobacco prevention programs targeted at female adolescents lend urgency to the development and delivery of effective school-based tobacco prevention programs for female adolescent population in Saudi Arabia.

Strengths and limitations

Among the strengths of our study is that the trained health instructors were able to deliver all 10 curriculum sessions completely and timely, and were able to administer a 2-year post-test survey to the same study cohort before graduating to high school. Furthermore, we used TPB to guide the development of study questionnaires and applied appropriate statistical analysis techniques nesting individual students within their schools. Our study has limitations. Sample size estimation was not performed for this study, as it was designed as a pilot study. Furthermore, baseline differences in gender might indicate possible selection bias due to lack of randomization. It is also likely that other sources of selection bias could have played a role in the pre-allocation phase. The extent to which this could have impacted our results is, however, difficult to estimate. The lack of behavior change probably reflects the

small numbers of smokers in both groups—33/379 (0.09%) in the intervention and 14/255 (0.05%) in the control and the likely absenteeism of these smokers. The less than optimal reliability indicates a need for revisiting the questions measuring the TPB constructs in future implementation of the program. Finally, the attrition rate was about 27% at 2-year post-test. The effect of non-differential attrition might have reduced the ability of DFND program to demonstrate effectiveness as a result of bias toward the null. These limitations may have generally contributed to the null findings in this study and, hence, our premature conclusion that the program was ineffective in reducing tobacco use. Clearly, administering a successful school tobacco prevention program, requires longer, more intensive multimodal interventions, which require the Patronage and political power of both the Ministry of Health and the Ministry of Education in every stage of program planning and implementation.

Conclusion

The tobacco prevention program, DFND, did not impact tobacco use in our study participants. In the short-term, DFND significantly improved knowledge and attitude toward not using tobacco among students. The effects of the program decayed 2 years post-intervention without additional programming or booster sessions.

Author Contributions

Both authors contributed in the conception and design of study, data analysis, and writing the manuscript. The first author also administered the program and collected the data.

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REFERENCES

1. World Health Organization. Report on the global tobacco epidemic—2011. http://whqlibdoc.who.int/hq/2011/WHO_NMH_TFI_11.3_eng.pdf. Accessed March 10, 2018.
2. Centers for Disease Control. Global tobacco surveillance system data. <http://www.cdc.gov/tobacco/global/>. Accessed March 10, 2018.
3. U.S. Department of Health and Human Services. *Preventing Tobacco Use Among Young People: A Report of the Surgeon General—1994*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office of Smoking and Health; 1994.
4. U.S. Department of Health and Human Services. *The Health Consequences of Smoking: A Report of the Surgeon General—2004*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2004.
5. U.S. Department of Health and Human Services. *Preventing Tobacco Use among Youth and Young Adults: A Report of the Surgeon General—2012*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2012.
6. World Health Organization. Adolescents: Health risks and solutions fact sheet—2017. <http://www.who.int/mediacentre/factsheets/fs345/en/>. Accessed February 7, 2018.
7. World Health Organization. WHO global report on trends in prevalence of tobacco smoking—2015. <http://apps.who.int/iris/bitstream/10665/156262/1/97>

- 89241564922_eng. Retrieved February 7, 2018.
8. Centers for Disease Control. Global youth tobacco survey: Fact sheet for Saudi Arabia—2010. http://www.emro.who.int/images/stories/tfi/documents/GYTS_FS_SAA_2010.pdf?ua=1. Accessed February 7, 2018.
 9. Thomas RE, Perera R. School-based programs for preventing smoking. *Cochrane Database Syst Rev*. 2006;3:CD001293. doi:10.1002/14651858.CD001293.pub2.
 10. Hwang MS, Yeagley KL, Petosa R. A meta-analysis of adolescent psychosocial smoking prevention programs published between 1978 and 1997 in the United States. *Health Educ Behav*. 2004;31(6):702-719. doi: 10.1177/1090198104263361
 11. Flay B. The promise of long-term effectiveness of school-based smoking prevention programs: a critical review of reviews. *Tob Induc Dis*. 2009;5(1):7. doi:10.1186/1617-9625-5-7.
 12. Centers for Disease Control and Prevention. *Best Practices for Comprehensive Tobacco Control Programs—2014*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014.
 13. O'Dell LE, Torres OV. A mechanistic hypothesis of the factors that enhance vulnerability to nicotine use in females. *Neuropharmacology*. 2014;76:566-580.
 14. Al Agili DE, Park HK. The prevalence and determinants of tobacco use among adolescents in Saudi Arabia. *J Sch Health*. 2012;82:131-138.
 15. Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process*. 1991;50:179-211.
 16. Ajzen I. Constructing a theory of planned behavior questionnaire. <http://people.umass.edu/ajzen/pdf/tpb.measurement.pdf>. Published 2006. Accessed October 12, 2014.
 17. Hill AJ, Boudreau F, Amyot E, Dery D, Godin G. Predicting the stages of smoking acquisition according to the theory of planned behavior. *J Adolescent Health*. 1997;21(2):107-115
 18. Park HE, Alagili DE, Bartolucci A. Factors affecting tobacco use among middle school students in Saudi Arabia. *Matern Child Health J*. 2012;16(9):1828-1836.
 19. Tobler NS. Lessons learned. *J Prim Prev*. 2000;20(4):261-274.
 20. El Mhamdi S, Sriha A, Bouanene I, Ben Salah A, Ben Salem K, Soltani MS. Predictors of smoking relapse in a cohort of adolescents and young adults in Monastir (Tunisia). *Tob Induc Dis*. 2013;11(1):12.
 21. García-Rodríguez O, Secades-Villaa R, Flórez-Salamancab L, Okudab M, Liu SM, Blanco C. Probability and predictors of relapse to smoking: results of the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). *Drug Alcohol Depend*. 2013;132(3):479-485.
 22. Abdalla AM, Al-Kaabba AF, Saeed AA, Abdulrahman BM, Raat H. Gender differences in smoking behavior among adolescents in Saudi Arabia. *Saudi Med J*. 2007;28(7):1102-1108.