



Published in final edited form as:

Health Educ Behav. 2011 June ; 38(3): 231–240. doi:10.1177/1090198110372330.

A mediation analysis of a tobacco prevention program for adolescents in India: How did Project MYTRI work?

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Abstract

This paper presents the results of a mediation analysis of Project MYTRI (Mobilizing Youth for Tobacco Related Initiatives in India), a randomized, controlled trial of a multiple component, school-based tobacco prevention program for 6th–9th graders (n=14085) in Delhi and Chennai, India. A mediation analysis identifies *how* an intervention achieves its effects. In MYTRI, changes in students' (a) knowledge about the negative health effects of tobacco; (b) beliefs about its social consequences; (c) reasons to use tobacco; (d) reasons not to use tobacco; (e) advocacy skills self-efficacy; and (f) normative beliefs about tobacco use were significantly associated with reductions in students' intentions to use tobacco and tobacco use behaviors. Changes in students' perceptions of the prevalence of (a) smoking and (b) chewing tobacco were significantly related to increases, in contrast, in students' intentions to use and use of tobacco. Implications for intervention design are considered.

INTRODUCTION

More than 400 million children and adolescents, the most of any country worldwide, call India home today (Youthreach, 2004). India is the youngest major nation in the world at present and will remain so for several decades to come. More than one-third of its one billion and growing population is less than 15 years old (UNFPA, 2009). This demographic advantage is expected to pay large dividends in the future, but can only do so if these youth stay healthy (Kalbag, 2006). Tobacco use is now a grave and growing threat to their health. During the first two decades of the 21st century, India shall experience the fastest increase in deaths attributable to tobacco worldwide, escalating from 1% of all deaths to over 13% (Reddy & Gupta, 2004). About 1 million people per year die from tobacco-related diseases at present (Jha et al., 2008). This figure is expected to rise to 1.5 million people per year by the year 2020 (Murray & Lopez, 1997). Most deaths due to tobacco occur at a younger age in India (35–50 years), compared to other countries (> 70 years) (Reddy & Gupta, 2004).

An estimated 5,500 young people start to use tobacco in India every day (Patel, 1999). According to the most recent Global Youth Tobacco Survey (2006), more than one-third of students aged 13–15 years (36.8%) report initiating tobacco use before the age of 10 (Sinha et al., 2008). The prevalence of tobacco use among young people in India has remained steady over the last few years, according to one study (Sinha et al., 2008), while another study shows it may be rising instead (Reddy et al., 2006). According to the most recent Global Youth Tobacco Survey (2006), 3.8% of students 13–15 years old currently smoke cigarettes in India, compared with 13.0% of students 13–15 years old in the United States (Sinha et al., 2008; Warren et al., 2007). In India, another 11.9% currently use other types of tobacco, like bidis or gutkha, compared to the United States, where another 10.6% of youth currently use other tobacco products (Sinha et al., 2008; Warren et al., 2007).

Early intervention in this context is clearly warranted. Yet, there is a dearth of such interventions available. Schools offer an outstanding environment in which to intervene,

given the importance that is placed upon education in this context (Sharma, 2003), but few students (54.4%) report learning about the dangers of tobacco use in school (Sinha, 2006). Only one large-scale study of a tobacco-focused intervention for young people in India has been conducted to date: Project MYTRI (Perry et al., 2006). MYTRI stands for ‘friendship’ in Hindi and is an acronym for ‘*Mobilizing Youth for Tobacco-Related Initiatives in India.*’ A two-year, school-based, multi-component intervention, MYTRI was designed to prevent and reduce tobacco use among 6th–9th graders in Private and Government schools in Delhi and Chennai. MYTRI was a collaborative study between scientists in the U.S. and India, a group-randomized, controlled trial. It was funded by the Fogarty International Center at NIH as part of a larger effort to build capacity in tobacco research, globally (Primack, 2006).

Details about its intervention program are published elsewhere (Perry et al., 2006), as are the results of process (Bate et al., 2009; Stigler et al., 2007) and outcome (Perry et al., 2009) evaluations. MYTRI is based on successful school-based prevention programs that have been developed in the West, “translated” for implementation in this setting (Perry et al., 2006; Stigler et al., 2007). After the first year of this two-year program, students in the intervention condition were significantly less likely to report having intentions to smoke or chew tobacco, compared to the controls (Stigler et al., 2007). A mediation analysis showed intervention-related (a) increases in student knowledge about the health consequences of tobacco, (b) reductions in their reasons to use tobacco, and (c) changes in normative beliefs were responsible for these effects (Bate et al., 2009). No changes in behavior were noted after the first year (Stigler et al., 2007). After the second year, students in the intervention group, compared to the control group, were still significantly less likely to intend to smoke or chew tobacco in the future. Over the two years, students were significantly less likely to increase cigarette and bidi smoking, too (Perry et al., 2009). It remains unclear how MYTRI achieved these effects. No mediation analysis of MYTRI, in its entirety, has been conducted. In particular, it remains unclear how MYTRI achieved changes in the tobacco use behaviors.

Mediation analysis is a statistical technique that can be used to connect intervention-related changes in intervening variables, like risk factors, to intervention-related changes in outcomes, like behaviors or intentions (MacKinnon, 2008). In other words, mediation analyses help identify variables (called ‘mediators’) that are responsible for an program’s effect (MacKinnon, 2008). In doing so, the mediation analysis tests theories that underlie an intervention (MacKinnon et al., 2002). If effective and ineffective elements of a program can be identified, and expanded or eliminated, respectively, then a particular intervention could ultimately cost less and provide greater benefit (MacKinnon, 2008). This feature is particularly appealing in this context, where prevention resources are scarce, and limited.

The purpose of this paper is to present the results of a mediation analysis of Project MYTRI. Specifically, it examines how this tobacco prevention program achieved its effects in regards to reducing students’ tobacco use intentions and tobacco use behaviors. The analysis considers MYTRI in its *entirety*, as a two-year tobacco prevention intervention. It identifies additional variables that appear to be responsible for and critical to its success.

METHODS

Study design

Project MYTRI was a group-randomized, controlled intervention trial (Murray, 1998). Sixteen schools in Delhi (in northern India) and sixteen schools in Chennai (in southern India) were recruited to participate in it, matched according to type of school (Private v. Government; Co-ed v. Boys-only v. Girls-only), and then randomly assigned to receive a tobacco intervention program (n=16 schools) or serve as a delayed intervention control (n=16 schools) (Perry et al., 2009). The intervention was implemented over two academic

years (2004–05 and 2005–06) with two cohorts of students. These students were in the sixth and eighth grades when the study began, in 2004, and in the eighth and tenth grades, respectively, when it ended, in 2006. Throughout the course of the study, these students participated in three repeated surveys: (a) in 2004, before the intervention began; (b) in 2005, between year 1 and 2 of the intervention; and (c) in 2006, after the intervention was complete. Ethical clearances for the study were obtained from appropriate ethics boards in India and the United States. Both passive parental consent and active student assent were required and obtained by researchers before proceeding with the study. The present study is a secondary analysis of these data – a mediation analysis of Project MYTRI in its entirety.

Participants

All students enrolled in participating schools in the 6th and 8th grades in 2004 (i.e., n=12,484), 7th and 9th grades in 2005 (i.e., n=12,075), and 8th and 10th grades in 2006 (i.e., n=12,752) were eligible and invited to complete each survey. The response rates were 94.1% (n=11,748), 94.7% (n=12,821), and 84.0% (n=10,625) in 2004, 2005, and 2006, respectively. Those who did not participate included parent refusals (<0.1–1%), student refusals (<0.1–1%), and absentees (4–5%). Make-up surveys were conducted at schools to reduce the number of absentees. In 2005 and 2006, 2 schools (1 intervention, 1 control) could not participate due to conflicting schedules. In 2006, 3 additional schools (2 controls, 1 intervention) would not let 10th graders participate because of pending national exams.

This study focuses on the 14,085 students who completed 1 or more of the 3 surveys: 6365 (45.3%) completed 3 surveys, 3780 (26.9%) completed 2 surveys, and 3918 (27.9%) completed 1 survey. The analytic method selected for the study uses maximum likelihood estimation techniques, which provide robust model estimates in the presence of missing data (Schafer & Graham, 2002) and non-normality (Muthén & Muthén, 1998–2007). The sample was 43.4% female. More than half (62.1%) were from Government (low-mid SES) schools (vs. Private schools); 46.5% were from Delhi (vs. Chennai); 50.9% were in the sixth grade at baseline (vs. eighth grade); and 45.3% were in intervention schools (vs. control).

Intervention

MYTRI is a two year, school-based, multiple component tobacco prevention program. The overall goal of the program was to reduce tobacco use among students in grades 6–9, including cigarette smoking, bidi smoking, and chewing tobacco (e.g., gutkha), which are common in this setting (Reddy et al., 2006). The objectives of the program were to change multiple intra-personal factors (e.g., knowledge, meanings, skills) and social-environmental factors (e.g., social norms) known to be related to tobacco use among urban Indian youth (Stigler et al., 2006). Intervention strategies included classroom activities, school posters, parent postcards, and peer-led health activism. The intervention model (Figure 1) is based on the social influences model (USDHHS, 1994) and Social Cognitive Theory, as well as other evidence-based smoking prevention programs “translated” for use in this setting (Perry et al., 2006). Extensive formative development, including multiple focus group discussions were an important part of this “translation” process (Mishra et al, 2005). The intervention spanned 4 months each year, over two years. Materials were developed and implemented in English, Hindi, and/or Tamil, according to each school’s requirements. The intervention strategies, objectives, and goals are shown in Figure 1 (Perry et al., 2006).

Measures

A self-administered, pencil and paper survey instrument was implemented in schools by teams of trained research staff using standardized protocols. Confidentiality of student responses was assured. A unique identification number not recognizable to students or school staff was used to track students over time, across repeated surveys. Surveys were

given in English, Hindi, and Tamil, based on each school's requirements, too. This survey was adapted from similar instruments, like the Global Youth Tobacco Survey (Warren et al, 2008), and underwent rigorous pilot testing before its administration (Reddy et al, 2006).

Multiple item summative scales were constructed from these questions to measure the outcomes and potential mediators of interest in this study. More information about these measures, including details specific to their psychometric properties, is included below, in Table 1, and other prior publications from this team (Bate et al, 2009; Stigler et al, 2006).

Outcomes—Two groups of variables were considered as potential outcomes for this mediation analysis: (a) tobacco use behaviors and (b) tobacco use intentions. Changes in tobacco use behaviors were observed after year two of the program, for past 30 day (i.e., past month) cigarette smoking and bidi smoking only (Perry et al., 2009). A single variable, therefore, was constructed to represent these two behaviors, combined in the mediation analysis as a single outcome. Changes in tobacco use intentions were observed after year one and year two of the intervention, for intentions to smoke or chew tobacco (Perry et al., 2009; Stigler et al., 2007). A single variable, therefore, was constructed to represent these two types of intentions, combined in the mediation analysis as a single outcome (Table 1).

Potential mediators—Twelve psychosocial risk factors related to tobacco use in this context were selected as potential mediators in the analysis. MYTRI endeavored to change these risk factors to, in turn, reduce tobacco use among these students in India (Figure 1). Multiple item summative scales created to measure the twelve potential mediators, which included (a) knowledge of health effects; (b) beliefs about social consequences; (c) reasons to use tobacco; (d) reasons not to use tobacco; (e) refusal skills self-efficacy; (f) knowledge of tobacco control policy; (g) support of tobacco control policy; (h) advocacy skills efficacy; (i) normative beliefs; (j) normative expectations; (k) perceived prevalence of smoking; and (l) perceived prevalence of chewing. More information about these is provided in Table 1.

Data Analysis

The mediation analysis was conducted using a parallel process approach to growth curve modeling (Cheong, MacKinnon, & Khoo, 2003). Changes in a potential mediator and changes in a particular outcome are conceptualized as parallel processes over time. The mediation analysis tests whether the intervention affects changes in a potential mediator over time which, in turn, affects changes in the outcome. The analysis is done in two steps.

In the first step, the growth of each process (i.e., change in the potential mediators and outcomes over time, from 2004 to 2006) is modeled. All indicators were standardized as they entered the model for each process so as to facilitate interpretation and subsequent analysis (MacKinnon, 2008). For the behavioral outcome growth curve, we used a logit link function to account for the binary format of the indicator variables for the behaviors. We estimated all growth curves using robust maximum likelihood. The growth curves for all potential mediators and outcomes were specified as a linear change process over time. In the absence of data beyond three time points, we could not consider quadratic or cubic growth functions. Model fit was assessed using a χ^2 goodness-of-fit test, the Comparative Fit Index (CFI; Bentler, 1990), and the root means square error of approximation (RMSEA; Steiger, 1990). Given the large sample size and complexity of these models, we relied more on the CFI and RMSEA in assessing fit, as the χ^2 test statistic is influenced by large sample sizes and non-normality (Brown, 2006). The final single-process models had CFI estimates ranging from 0.96 to 1.00 and RMSEA estimates ranging from 0.00 to 0.05, all of which are well within threshold values considered to be indicators of good fit (Hu & Bentler, 1999).

In the second step, following the rationale and statistical procedure given by Cheong, MacKinnon, and Khoo (2003), the single-process model for each potential mediator was combined with the single-process model for each outcome into a parallel process model (Figure 2). A series of parallel process models was then run for each set of mediators with the outcome. Hypothesized relations between changes in the potential mediator and the changes in the outcome over time, given the intervention, were subsequently investigated. These models provided the necessary parameters to conduct the mediation analysis. An effect is said to be mediated if (a) the intervention has a statistically significant effect on a potential mediator (α); (b) the potential mediator is significantly related to the outcome (β), after adjusting for the intervention's effect; and (c) the mediated effect, calculated as the product of these two estimates ($\alpha\beta$), is statistically significant, as well (Figure 2). In the parallel process models, the focus is on the growth rates over time (e.g., η_1 , Figure 2).

The analysis included both single and multiple mediator models (MacKinnon, 2008) (see Figure 2). In the single mediator models, each potential mediator was considered separately. In the multiple mediator models, the effect of several mediators was assessed concurrently, using mediators that were statistically significant in single mediation models.

Analyses were conducted using *Mplus* 5.1 (Muthen & Muthen, 1998–2007). Estimates of the mediated effect ($\alpha\beta$) and its standard error were obtained using the '*model indirect*' statement. Asymmetric confidence intervals were estimated using *Prodclin* (MacKinnon, Fritz, Williams, & Lockwood, 2007). All programs were adapted from those provided by Cheong et al (2003), from their prior analytic work in parallel process mediation analyses.

RESULTS

The analysis identified variables that had a positive effect on the program's outcomes ('consistent mediators') and variables that had a negative effect ('inconsistent mediators'). These two groups, or types, of mediators are considered separately below. Some variables ('non-significant mediators') had neither a positive or negative effect (see Table 2 for all).

Consistent mediators

Table 2 presents the results of the mediation analysis, in single mediator models, for behaviors and intentions. The intervention had a consistent, positive effect on five of the twelve hypothesized mediators for both the behavior and the intention models: knowledge of health effects, reasons to use, reasons not to use, advocacy skills efficacy and normative beliefs (α). All of these change processes, in turn, had a negative effect on the behavior and the intention outcomes (β). The product of these effects, or the indirect effect ($\alpha\beta$), was significant for all, which is indicative of mediation. One additional process, beliefs about social consequences, was also a consistent mediator for intentions to use tobacco, as well.

When these statistically significant mediators were added to multiple mediator models, only reasons to use tobacco and normative beliefs remained statistically significant for tobacco use behaviors, accounting for 41% and 22% of the intervention's total effect, respectively. In the multiple mediator models for tobacco use intentions, only normative beliefs remained statistically significant, accounting for 95% of the total intervention effect.

Inconsistent mediators

Two variables were identified as inconsistent mediators in the single mediator models: perceived prevalence of chewing and perceived prevalence of smoking (see Table 2). That is, the intervention had a significant, but negative, effect on these mediators which, in turn, increased both tobacco use intentions and behaviors. Inconsistent mediation occurs when the

direct effect on the potential mediator (α) and its corresponding mediated effect ($\alpha\beta$) have opposite signs (i.e., one is negative and the other is positive) (MacKinnon et al., 2000).

Non-significant mediators

The estimate of the mediated effect ($\alpha\beta$) was not significant for some variables (see Table 2). For tobacco use behaviors, these included beliefs about social consequences, refusal skills self-efficacy, support for tobacco control policy, knowledge of tobacco control policy and normative expectations. For tobacco use intentions, all of the same variables were non-significant mediators, as well, except beliefs about social consequences.

DISCUSSION

In recent years, many researchers and practitioners have come to the conclusion that school-based tobacco (and/or other drug) prevention programs do not work (e.g., Glantz & Mandel, 2005; Weiss et al., 2005). A more accurate conclusion would be that some school-based programs work (i.e., produce short- and/or long-term effects), while others do not (Flay, 2007). Simply put, all school-based tobacco prevention programs are not created equally. Comprehensive reviews and meta-analyses confirm that certain characteristics of school-based programs surely contribute to success. The most effective programs: (a) are interactive (e.g., Cuijpers, 2002; Tobler, 2000); (b) engage similar-age peers as facilitators (Cuijpers, 2002; Tobler, 2000); (c) involve other segments of the community (e.g., parents) (Flay, 2000); (d) are based on the social influences model (e.g., Hwang et al., 2004); (e) are conducted across multiple sessions and multiple years, in early to mid adolescence (Flay, 2007); and (f) provide adequate training and support (Glynn, 1989). Project MYTRI shares these characteristics. Its short-term effects were significant and strong (Perry et al., 2009).

Another body of evidence is emerging that further elucidates how the effective school-based tobacco (and/or other drug) prevention programs work. The focus of these studies is on program content. The mediation analyses connect program objectives (e.g., decreases in risk factors for tobacco use) to program goals (e.g., reductions in intentions to smoke or chew tobacco). Several mediation analyses of school-based alcohol prevention programs have been published, including studies of the Alcohol Misuse Prevention Study (Wynn et al., 1997, 2000), the Adolescent Alcohol Prevention Trial (Donaldson et al., 1994), and Project Northland (Komro et al., 2001). Mediation analyses of school-based prevention programs that address multiple forms of drug use (including tobacco use) have been published, also, including Project ALERT (Orlando et al., 2005), Life Skills Training (Botvin et al., 1992), and the Midwestern Prevention Project (MacKinnon et al., 1991). These mediation analyses of MYTRI are, to the best of our knowledge, the only ones specific to a tobacco-only program.

The present analysis extends previous work from this team (Bate et al., 2009). In doing so, a larger set of mediators was identified. They included: (a) knowledge about the health effects of tobacco use; (b) beliefs about the social consequences; (c) reasons to use tobacco; (d) reasons not to use tobacco; (e) advocacy skills self-efficacy; and (f) normative beliefs. Inconsistent mediators were identified, too, mirroring results of the prior analysis (Bate et al., 2009): (a) perceived prevalence of smoking and (b) perceived prevalence of chewing. Changes in (a) reasons to use tobacco and (b) normative beliefs appear to be particularly paramount to reducing tobacco use behaviors and intentions among youth in this context, as they accounted for the majority of Project MYTRI's effect on the two outcome variables.

Enhancing students' knowledge about the negative effects of a behavior, like tobacco use, is not typically considered an important ingredient of intervention programs. Early efforts to prevent and/or reduce tobacco use in the West demonstrated that information alone does not

typically change behavior and can actually make things worse (Goodstadt, 1978, 1980). In this study, intervention-related changes in knowledge of and beliefs about the consequences of tobacco use, including negative health and social effects, were related to reducing tobacco use behaviors and intentions. Improving student knowledge about the consequences of tobacco use was also a significant mediator of the Life Skills Training program's reductions in cigarette smoking (Botvin et al., 1992), as well as Project ALERT's decreases in intentions to smoke cigarettes, too (Orlando et al., 2005). Our early formative research suggested knowledge about the negative health consequences of tobacco use, for example, was not always accurate among school-going youth in India (Mishra et al., 2005). Chewing tobacco (e.g., gutkha) was thought to be less harmful than smoking cigarettes, and many students thought that quitting tobacco use quickly could actually harm one's health (Mishra et al., 2005). Improving recognition of the negative health and social consequences of tobacco use may be especially important in India, as the tobacco epidemic is beginning.

Changing students' expectations about the outcomes of tobacco use, therefore, was an objective of our program, as was modifying their expectancies. Both are key constructs in Social Cognitive Theory (see Baranowski et al., 2002), upon which our intervention model is based (Perry et al., 2006). Expectations are one's perceptions about what shall happen as a result of engaging in a certain behavior (e.g., "If I smoke cigarettes, I will look 'cool' or 'grown-up'"). Expectancies, in turn, are the values that one places on that expectation (e.g., "It is important to me to look 'cool' or 'grown-up'") (Baranowski et al., 2002). Expectancies can be either positive or negative in form. They motivate one to engage or not to engage in a certain behavior, like tobacco use. Enhancing this motivation appears to be another key element of Project MYTRI. In this study, decreasing students' reasons to use tobacco and increasing their reasons not to use tobacco were significant mediators of the intervention effect on tobacco behaviors and intentions. This is consistent with the mediation analysis of Project Northland, where changes in the functional meanings of alcohol use were linked to reductions in the tendency to use alcohol use over time (a measure which included both behaviors and intentions) (Komro et al., 2001). Project MYTRI and Project Northland seek to help students clarify reasons why a young person would want to use tobacco (or drink alcohol) and, in doing so, assist students with identifying alternatives to meet that need (or function). Both interventions reinforce reasons why students do not want to use tobacco (or drink alcohol), too. Peers, parents, and film (i.e., Bollywood) stars, particularly, are key sources of influence in young Indian lives (Sharma et al., 2003). Their use of tobacco makes smoking and chewing appear 'cool,' 'fun,' 'fashionable,' and 'functional' (Mishra et al., 2005).

School-based tobacco (and/or other drug) prevention programs that are based on the social influences model help students identify and resist social influences to use tobacco (or other drugs). Resistance skills training is considered an essential part of the approach. An activity often focuses on teaching students how to say 'no' to tobacco (or other drugs) and provides opportunities for them to practice this skill, seeking to increase their confidence about saying 'no' in multiple situations (i.e., increasing their resistance skills self-efficacy). Interestingly, resistance, or refusal, skills efficacy was not a significant mediator in MYTRI. The program did not have any measurable effects on this risk factor. This non-significant effect is consistent with the results of other mediation analyses of other programs, like the Midwestern Prevention Project (MacKinnon et al., 1991), Adolescent Alcohol Prevention Trial (Donaldson et al., 1994), Alcohol Misuse Prevention Study (Wynn et al., 1997, 2000).

Project MYTRI sought not only to increase students' refusal skills self-efficacy, but also their advocacy skills self-efficacy. Community-based youth empowerment programs focus a great deal on enhancing advocacy skills and have met with some success (e.g., American Legacy Foundation, 2007; Holden et al., 2004), but this skill is not typically addressed in

school-based programs, explicitly. Peer-led health activism was an integral component of Project MYTRI. Wherever possible, students were given opportunities to lead activities, some of which focused on increasing students' confidence about advocating for tobacco-free homes, schools, and communities, and others on their confidence in helping friends and family members quit tobacco use. The latter point was a special need identified early in Project MYTRI, during our formative research phase (Mishra et al., 2005). Policies to curb the use of tobacco in India (e.g., restricting age of sale, prohibiting smoking in public places) are new to this context. The first national Tobacco Control Act was passed in 2004, at the start of MYTRI (Reddy et al., 2005). Implementation and active enforcement of this law is underway, but poor, in different regions of India (Sinha et al., 2008). Educating these students about the new law was a critical part of Project MYTRI, as was building students' skills to advocate on its behalf. Increasing student's confidence in advocating for tobacco-free places (e.g., schools) appeared to change their own tobacco intentions and behaviors.

Programs based on the social-influences model also seek to change social norms about tobacco use. They endeavor to make tobacco use less acceptable and try to correct young people's overestimates of peer and adult tobacco use. Changing social norms appears to be a particularly potent ingredient of many school-based programs. Mediation analyses of the Life Skills Training program (Botvin et al., 1992), the Adolescent Alcohol Prevention Trial (Donaldson et al., 1994), the Midwestern Prevention Project (MacKinnon et al., 1991), and the Alcohol Misuse Prevention Study (Wynn et al., 1997, 2000) consistently report changes in social norms (e.g., normative expectations, perceived prevalence) as key mediators. In Project MYTRI, normative beliefs was a significant mediator, as was perceived prevalence. Perceived prevalence, however, was an inconsistent mediator. That is, over time, students in the intervention condition perceived that tobacco use was more prevalent in their social environment, compared to students in the control condition. This change was related to an increase in students' behaviors and intentions. It hurt Project MYTRI's intervention effect. Compared to other countries in the West, like the United States, India is at a different stage of the tobacco epidemic. Tobacco use is increasing (John, 2005), not decreasing (Giovino et al., 2009). Correcting (mis-)perceptions about the prevalence of tobacco use in this social environment might be more challenging than it is in the United States. Clearly, though, this is an important way in which Project MYTRI could surely be improved. MYTRI was able to alter normative beliefs, in the right direction. Compared to students in the control group, students in the intervention condition believed more strongly that tobacco use was simply not acceptable among their peers or other adults over time. This change, then, was related to a reduction in students' behaviors and intentions. Strengthening this social norm will be critical in this context, as tobacco marketing practices seek to weaken it (Arora et al., 2008).

Critics suggest that mediation is an intra-individual process that unfolds over time (Collins, Graham, Flaherty, 1998). In this analysis, mediation was assessed, instead, as an inter-individual process that unfolded over time. Despite known limitations, the latter approach is widely accepted and applied now to studies of this kind, providing useful information that can be used to improve an intervention's design (MacKinnon, 2008). Although the sample of schools for Project MYTRI was not randomly selected from the population, they were purposefully chosen to represent the mix of types of schools in Delhi and Chennai. In doing so, the study provides a longitudinal sample of students of lower to higher socioeconomic status, based on school types, and both genders (Reddy et al., 2006).

IMPLICATIONS

The need for effective tobacco control interventions in India is critical, especially for young people, given the early age of initiation for tobacco use. In this context, resources are limited, so it helpful to note what works and hone in on why. This mediation analysis was

able to explain > 60% and > 90% of MYTRI's effect on tobacco use behaviors and intentions, respectively. The findings from this analysis suggest that increasing knowledge about the negative health and social consequences of tobacco use is important here, as is clarifying the meanings that surround tobacco use for young people in India, helping them identify alternatives to meet certain needs (e.g., to look 'cool,' 'fashionable,' or 'western'). Building strong social norms, or environments (e.g., schools, homes) where tobacco use is not acceptable, is also critical in this context. Enhancing students' ability to advocate for these tobacco-free environments appears to be an essential ingredient in prevention, too. Strengthening these aspects of MYTRI could enhance its behavioral effects, as could more appropriate corrections of students' misperceptions about the prevalence of tobacco use. The impact of MYTRI could be substantial if it were to be disseminated across the country. Results of this mediation analysis should be carefully considered before any dissemination. Other kinds of tobacco interventions in India may benefit from addressing these mediators (e.g., social norms, reasons to use) as they seek to reduce tobacco use among youth, also.

Acknowledgments

We would like to recognize Ms. Abha Tiwari, Ms. Radhika Shrivastav, and Ms. Anika Singh for their long-term contributions to this project and the many field staff who assisted, too. This research was funded by a grant from Fogarty International Center, National Institutes of Health (R01TW005952 Perry, PI), 'Mobilizing Youth for Action Against Tobacco in India.'

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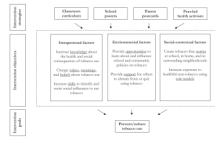


Figure 1.
Conceptual model for Project MYTRI: intervention strategies, objectives, and goals

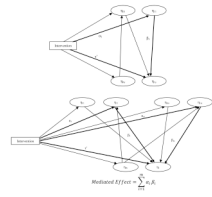


Figure 2. Diagrams of single (A) and multiple (B) mediator pathways for the parallel process growth curves. η_0 values represent the intercept growth factors and η_1 values represent the slope growth factor. The second subscript designates the mediators (1 and m for multiple) and the outcome (y). The mediated pathways are indicated by the indirect effects, α and β , and the direct effect, τ' .

Table 1

Multiple item scales used to measure outcomes and potential mediators.

| Variable | Items | Range | Alpha ^a | Example of item on scale |
|--------------------------------------------------|-------|---------------------|--------------------|----------------------------------------------------------------------------------|
| Outcomes | | | | |
| Smoke Cigarettes or Bidis ^e | 2 | 0 – 1 | n/a | Have you smoked cigarettes [or bidis] in the past 30 days? |
| Intentions to Chew or Smoke ^e | 4 | 0 – 24 ^c | 0.86 | Do you think that you will try smoking tobacco ... in the next year? |
| Potential Mediators | | | | |
| Knowledge of Health Effects ^e | 5 | 0 – 10 ^b | 0.66 | Does using tobacco as a young person harm your health immediately? |
| Beliefs about Social Consequences ^e | 5 | 0 – 15 ^c | 0.88 | If you used tobacco, do you think ... your parents would get angry? |
| Reasons to Use Tobacco ^e | 6 | 0 – 18 ^c | 0.73 | Does using tobacco make a person appear to be more brave and grown up? |
| Reasons Not to Use Tobacco ^e | 5 | 0 – 15 ^c | 0.84 | I would not want to use tobacco because ... my friends don't use tobacco. |
| Refusal Skills Self-Efficacy ^e | 5 | 0 – 15 ^c | 0.98 | Do you think you could say "no" if ... a close friend gave you tobacco? |
| Knowledge of Tobacco Control Policy ^e | 3 | 0 – 6 ^b | 0.60 | Does your state have a law which stops people ... from smoking in public places? |
| Support for Tobacco Control Policy ^e | 5 | 0 – 15 ^c | 0.79 | Should smoking be permitted in public places? |
| Advocacy Skills Self-Efficacy ^e | 8 | 0 – 21 ^c | 0.93 | Do you think you could ... help a friend stay away from trying tobacco? |
| Normative Beliefs ^e | 6 | 0 – 18 ^c | 0.79 | Is it okay ... for people of your age to try tobacco out of curiosity? |
| Normative Expectations ^e | 6 | 0 – 18 ^c | 0.91 | If you were to use tobacco, do you think ... your close friends would like it? |
| Perceived Prevalence of Smoking ^e | 4 | 0 – 12 ^d | 0.64 | How many people your age in India do you think smoke tobacco regularly? |
| Perceived Prevalence of Chewing ^e | 4 | 0 – 12 ^d | 0.66 | How many boys of your age in India do you think chew tobacco regularly? |

^aValue of Cronbach's alpha at baseline.^bRated on knowledge scale: Yes, No, Don't know.^cRated on agreement scale: Surely yes, Maybe yes, Maybe no, Surely no.^dRated on frequency scale: None, Some, A few, Most.^eA higher score on this scale indicates less risk or, conversely, is more protective.

Table 2

Results of the single mediator models; Project MYTRI, 2004–2006 (n=14,085).

| | α Est. (SE) | β Est. (SE) | $\alpha\beta$ Est. (SE) | $\alpha\beta$ 95% CI |
|--------------------------------------------------|-------------------------------------------------|-------------------------------------------------|----------------------------------------|-------------------------|
| | <i>Program's effect on the mediator</i> | <i>Mediator's effect on the outcome</i> | <i>Estimate of the mediated effect</i> | |
| BEHAVIORS^b | | | | |
| <i>Consistent mediators</i> | | | | |
| Knowledge of Health Effects ^a | 0.14 (0.01)* | -2.29 (0.42)* | -0.31 (0.06)* | -0.44, -0.19 |
| Reasons to Use ^a | 0.09 (0.01)* | -1.45 (0.18)* | -0.13 (0.02)* | -0.18, -0.09 |
| Reasons Not to Use ^a | 0.04 (0.01)* | -2.73 (0.43)* | -0.12 (0.04)* | -0.19, -0.04 |
| Advocacy Skills Self-Efficacy ^a | 0.04 (0.01)* | -1.72 (0.48)* | -0.06 (0.02)* | -0.12, -0.02 |
| Normative Beliefs ^a | 0.06 (0.01)* | -0.85 (0.11)* | -0.05 (0.01)* | -0.08, -0.02 |
| <i>Inconsistent mediators</i> | | | | |
| Perceived Prevalence of Chewing ^a | -0.12 (0.01)* | -0.61 (0.12)* | 0.07 (0.02)* | 0.04, 0.10 |
| Perceived Prevalence of Smoking ^a | -0.12 (0.01)* | -1.82 (0.33)* | 0.22 (0.05)* | 0.14, 0.32 |
| <i>Non-significant mediators</i> | | | | |
| Beliefs about Social Consequences ^a | 0.02 (0.01) | -2.61 (0.48)* | -0.05 (0.04) | -0.13, 0.01 |
| Refusal Skills Self-Efficacy ^a | -0.01 (0.01) | -1.33 (0.57)* | 0.02 (0.02) | -0.01, 0.06 |
| Support for Tobacco Control Policy ^a | 0.02 (0.01) | -0.97 (0.16)* | -0.01 (0.01) | -0.04, 0.01 |
| Knowledge of Tobacco Control Policy ^a | 0.15 (0.01)* | 0.07 (0.44) | 0.01 (0.07) | -0.12, 0.14 |
| Normative Expectations ^a | 0.00 (0.01) | -1.84 (0.31)* | -0.00 (0.03) | -0.05, 0.05 |
| INTENTIONS^c | | | | |
| <i>Consistent mediators</i> | | | | |
| Knowledge of Health Effects ^a | 0.14 (0.01)* | -1.23 (0.42)* | -0.17 (0.06)* | -0.29, -0.05 |
| Beliefs about Social Consequences ^a | 0.03 (0.01)* | -0.54 (0.13)* | -0.02 (0.01)* | -0.03, 0.00 |
| Reasons to Use ^a | 0.08 (0.01)* | -0.86 (0.04)* | -0.07 (0.01)* | -0.09, -0.04 |
| Reasons Not to Use ^a | 0.05 (0.01)* | -0.38 (0.06)* | -0.02 (0.01)* | -0.03, -0.01 |
| Advocacy Skills Self-Efficacy ^a | 0.04 (0.01)* | -0.72 (0.27)* | -0.03 (0.01)* | -0.06, -0.01 |
| Normative Beliefs ^a | 0.05 (0.01)* | -0.82 (0.05)* | -0.04 (0.01)* | -0.06, -0.02 |
| <i>Inconsistent mediators</i> | | | | |
| Perceived Prevalence of Chewing ^a | -0.14 (0.01)* | -0.42 (0.08)* | 0.06 (0.01)* | 0.04, 0.08 |
| Perceived Prevalence of Smoking ^a | -0.12 (0.01)* | -0.48 (0.10)* | 0.06 (0.01)* | 0.03, 0.09 |
| <i>Non-significant mediators</i> | | | | |
| Refusal Skills Self-Efficacy ^a | -0.01 (0.01) | -0.21 (0.06)* | 0.00 (0.00) | 0.00, 0.01 |
| Support for Tobacco Control Policy ^a | 0.01 (0.01) | -1.01 (0.07)* | -0.01 (0.01) | -0.03, 0.02 |
| Knowledge of Tobacco Control Policy ^a | 0.15 (0.01)* | -0.15 (0.08) | -0.02 (0.01) | -0.05, 0.00 |

| | α Est. (SE) | β Est. (SE) | $a\beta$ Est. (SE) | $a\beta$ 95% CI |
|-------------------------------------|-------------------------------------------------|-------------------------------------------------|----------------------------------------|--------------------|
| | <i>Program's effect on the mediator</i> | <i>Mediator's effect on the outcome</i> | <i>Estimate of the mediated effect</i> | |
| Normative Expectations ^a | -0.01 (0.01) | -0.95 (0.07)* | 0.00 (0.01) | -0.02, 0.03 |

^a A higher score on this scale indicates less risk or, conversely, is more protective.

^b See Table 1. Measured as past 30 day use of either cigarettes or bidis.

^c See Table 1. Measured as intentions to smoke or chew tobacco in the future.

* $p < 0.05$