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Implementation of an evidence-based tobacco control intervention for school teachers in India: Evaluating the effects of a capacity-building strategy

Eve M. Nagler[1,2], Mangesh Pednekar[3], Dhirendra Narain Sinha[3], Anne M. Stoddard[1], Sameer Narake[3], Keyuri Adhikari[4], Leah Jones[1], Harry Lando[5], Mary Vriniotis[6], Prakash Gupta[3] and Glorian Sorensen[1,2]

Abstract

Background

Tobacco-Free Teachers, Tobacco-Free Society (TFT-TFS) is an evidence-based intervention that promotes tobacco use cessation among teachers and tobacco control policies among schools in India. This study tested an implementation model to build Bihar Department of Education (DOE) capacity to support and deliver TFT-TFS within schools, leveraging DOE training infrastructure.

Method

We used a training-of-trainers (TOT) "cascade" implementation strategy to embed the TFT-TFS program into the Bihar DOE infrastructure. We trained 46 Cluster Coordinators to train and support Headmasters to implement TFT-TFS in their schools over one academic year. We selected three school districts, representing approximately 46 clusters and 219 schools. We used the RE-AIM framework to assess program adoption (Headmaster participation in at least one of six TFT-TFS trainings), implementation (of four core program components), and reach (teachers' participation in three or more group discussions). Using a non-inferiority design, we hypothesized that program adoption, implementation, and reach would not be inferior to the high standards demonstrated when TFT-TFS was originally tested in the Bihar School Teachers Study. We used self-reported checklists to measure outcomes and SPSS Version 25 to analyze data.

Results

For adoption, 94% of Headmasters attended the first training, although participation declined by the sixth training. Among the 112 schools out of 219 with complete Headmaster checklist data, all met our minimum criteria for implementing TFT-TFS. Over 99% of schools posted a school tobacco control policy and distributed quit booklets. However, only 69% of schools met our criteria for program reach.

[1]Center for Community-Based Research, Dana-Farber Cancer Institute, Boston, MA, USA
[2]Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston, MA, USA
[3]Healis-Sekhsaria Institute for Public Health, Navi Mumbai, India
[4]School of Pharmacy, West Virginia University, Morgantown, WV, USA
[5]School of Public Health, University of Minnesota, Minneapolis, MN, USA
[6]Brown-Lifespan Center for Digital Health, Rhode Island Hospital, Providence, RI, USA

Corresponding author:
Eve M. Nagler, Center for Community-Based Research, Dana-Farber Cancer Institute, 450 Brookline Avenue, LW642, Boston, MA 02215, USA.
Email: eve_nagler@dfci.harvard.edu

Conclusions

This study outlines the processes for taking a tobacco control intervention to scale and implementing it through the Bihar DOE infrastructure. These findings provide a foundation for other Indian states and low- and middle-income countries to implement tobacco control and other health programs for schoolteachers.

Trial registration

NCT05346991.

Plain Language Summary: Each year in India, more than 1.2 million people die from tobacco-related causes, and India has the world's highest oral cancer burden. The world needs more evidence on how to bring cost-effective tobacco control interventions to scale, especially in low- and middle-income countries (LMICs). To address this gap, from 2017 to 2021, we examined the process of scaling up *Tobacco-Free Teachers, Tobacco-Free Society* (TFT-TFS), an evidence-based intervention promoting tobacco use cessation among teachers and tobacco control policies in schools. Our study tested an implementation model aimed at building the Bihar State Department of Education (DOE) capacity to support and deliver TFT-TFS. We used a training-of-trainers model to embed TFT-TFS into Bihar DOE infrastructure, training 46 Cluster Coordinators to in turn train and support Headmasters to implement TFT-TFS over one academic year. We hypothesized that program adoption, implementation, and reach would not be inferior to the high standards demonstrated when we originally tested TFT-TFS through the Bihar School Teachers Study (2013–2017). For adoption, 94% of Headmasters attended the first training, although participation declined by the sixth training. Of 112 schools (out of 219 with complete Headmaster checklist data), all met our minimum criteria for implementing TFT-TFS. Over 99% of schools posted a school tobacco control policy and distributed quit booklets. However, only 69% of schools met our criteria for program reach. Study findings offer other Indian states and LMICs lessons to implement tobacco control and other health programs for schoolteachers within educational systems.

Keywords

tobacco control program, training-of-trainers, schools, teachers, implementation research, RE-AIM framework, low- and middle-income countries

Introduction

According to the World Health Organization, tobacco kills almost 50% of the people who use it. More than 8 million people globally die each year from tobacco-related illnesses, with 80% of the world's 1.3 billion tobacco users residing in low- and middle-income countries (LMICs; World Health Organization, 2021). With the growing global burden of tobacco-related chronic illness and death caused by smoking, secondhand smoke, and smokeless tobacco, particularly in LMICs, there is a profound need for cost-effective, evidence-based interventions (EBIs) that promote tobacco control on a large scale. There is also insufficient evidence on best practices to embed EBIs into existing government infrastructures.

With 274 million tobacco users in 2017 (Ministry of Health and Family Welfare, 2018), India is the world's second-largest consumer of tobacco products after China (GBD 2019 Tobacco Collaborators, 2021). Almost 29% of India's adult population use smokeless (e.g., khaini and gutka), smoked (e.g., cigarettes and the unfiltered bidi), or both forms of tobacco, with 42% of men and 14% of women reporting regular tobacco use in 2016 (Jha et al., 2008; Sinha et al., 2014). Each year in India, more than 1.2 million people die from tobacco-related causes (Jha & Peto, 2014; Sinha et al., 2014). Accordingly, India has the world's highest oral cancer burden (Reddy & Gupta, 2004).

Tobacco control EBIs that actively engage community leaders and institutions can bolster government tobacco control efforts and reduce tobacco use (Chatterjee et al., 2020; Sorensen et al., 2005, 2013). However, there is scant evidence on best practices for bringing effective tobacco control EBIs to scale (Pednekar et al., 2018). To address this gap, from 2017 to 2021, we conducted a study to examine the process of scaling up the *Tobacco-Free Teachers, Tobacco-Free Society* (TFT-TFS) program—an EBI that promotes tobacco use cessation among teachers and tobacco control policies among schools (Sorensen et al., 2013). This study tested an implementation strategy aimed at building the capacity of the Bihar State Department of Education (DOE) to support and deliver the TFT-TFS program within schools, leveraging the DOE curriculum training infrastructure as an established process.

In India, teachers are influential role models for young people and for society at-large, yet are an underutilized resource for promoting tobacco control. Leveraging the role of teachers as leaders, and schools as nodes of community intervention, TFT-TFS was designed to provide teachers with the knowledge and skills to quit tobacco use or to help someone else to quit. The program was also designed to help schools comply with national tobacco control policies—and to set the stage for the next generation to be tobacco-free.

We previously demonstrated the efficacy of the TFT-TFS program in the Bihar School Teachers Study (BSTS, 2008–2014) in 72 government schools from 10 districts using a cluster randomized design (Sorensen et al., 2013). Immediately post-intervention, we found adjusted quit rates of 50% among tobacco-using teachers in intervention schools, compared to 15% among tobacco-using teachers in control schools ($p < .001$). Differential benefits persisted after 6 months; the adjusted sustained quit rate was 19% in the intervention group versus 7% among controls ($p = .06$). All 36 intervention schools and only one control school reported adopting a tobacco control policy immediately post-intervention. There was higher enforcement of the school tobacco control policy post-intervention compared to baseline in intervention schools ($OR = 3.26$; CI: [2.35, 4.54]; Mathur et al., 2016). Process evaluation data also showed that the intervention was generally delivered as planned, for example, session delivery was 100% in 33 of the 36 intervention schools and 31 schools implemented all program components (Pawar et al., 2015).

The study reported here, Disseminating an Evidence-based Tobacco Control Intervention for School Teachers in India (2017–2021), used a training-of-trainers (TOT) "cascade" approach to embed TFT-TFS into the Bihar DOE infrastructure. LMICs often utilize a TOT to reach large numbers of trainees exponentially and at low cost (Mormina & Pinder, 2018). Our TOT model trained education curriculum trainers, that is, Cluster Coordinators, to train and support Headmasters to implement the TFT-TFS program in their schools. We used the Reach, Effectiveness, Adoption, Implementation, and Maintenance (RE-AIM) framework to assess program adoption, implementation, and reach (Glasgow et al., 1999). RE-AIM has been widely used to examine program implementation in real-world settings and translate findings into practice (Quinn et al., 2019), yet RE-AIM's application in LMICs is limited (Mitchell-Gillespie et al., 2020; Onono et al., 2018). We hypothesized that, as achieved in BSTS, the TFT-TFS program would meet acceptable rates of adoption, implementation, and reach, but this time using a TOT model through an existing DOE infrastructure.

The objectives of this manuscript are to: (a) Describe the TOT model used to deliver the TFT-TFS program through the Bihar DOE's established processes and systems; and (b) Present the extent of the TFT-TFS program's adoption, implementation, and reach. Hypotheses include:

Adoption: At least 80% of participating schools will adopt the program, defined as a school's Headmaster (or designee) attending at least one TFT-TFS program training.
Implementation: Among schools that adopted the program, at least 80% of schools will implement a minimum standard for program implementation, defined as implementing the four core program components within the school.
Reach: Among schools that implemented the program, at least 80% of teachers will participate in teacher discussion sessions covering three or more of the six TFT-TFS monthly themes.

Method

Study Design

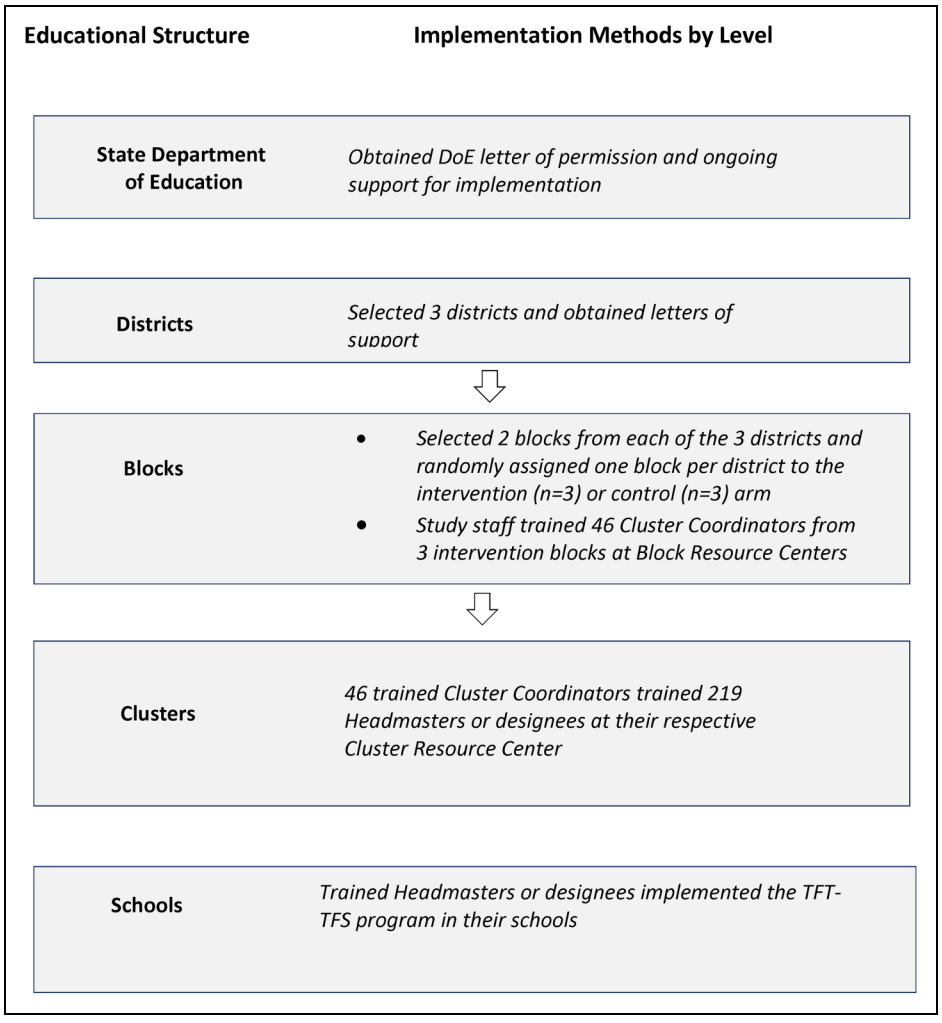
This study—a 5-year cluster randomized trial—used a Hybrid III effectiveness-implementation design (Curran et al., 2012) to assess the effect of delivery of the TFT-TFS program using a cascade TOT approach. A Hybrid III design is used when a study is focused primarily on implementation outcomes, with the secondary aim of assessing clinical outcomes (Curran et al., 2012; Landes et al., 2019). We selected a TOT model as our implementation strategy based on the DOE infrastructure and prior research with DOE officials who identified cascade training as the model for training Headmasters (Pednekar et al., 2018). Working through the Bihar State DOE, our implementation strategy used the cluster-level infrastructure for curriculum training to build the capacity of Headmasters to implement TFT-TFS within their schools. Cluster Coordinators are responsible for training and supporting approximately 8–10 school Headmasters within their cluster. We used a non-inferiority design to test if program adoption, implementation, and reach would not be inferior to the high standards demonstrated in BSTS (Sorensen et al., 2013). We report the evaluation of our implementation strategy and outcomes following the StaRI standard (StaRI Group, 2017). The Harvard T.H. Chan School of Public Health's Office of Regulatory Affairs and Research Compliance (IRB16-1055) and the Healis-Sekhsaria Institute for Public Health Institutional Ethics Committee (OHRP: IRB00007340; FWA00019699) approved the study. We also obtained consent and permission from Bihar state, district, and block-level DOE officials for schools to participate in this study.

Study Setting

The northern Indian state of Bihar has an estimated population of 119 million (*India Growing*, 2022) and is one of India's poorest states, with a poverty rate of 33.7%, compared to 21.9% nationally. Only 11.3% of Bihar's population is urban, compared to 31.2% of India overall. A reported 43% of men, 7% of women, and 26% of all adults in Bihar either smoked tobacco and/or used smokeless tobacco the year of the study launch (Ministry of Health and Family Welfare, 2018). Bihar is divided into 38 districts, which are further divided into blocks for administrative purposes; the DOE divides blocks into clusters of middle and primary schools.

Of Bihar's 38 districts, after excluding the 10 districts that participated in BSTS, we selected three study districts for their proximity to the state capital of Patna. Within each study

Figure 1
Bihar Department of Education Structure and Implementation Methods



district, we selected two blocks and randomly assigned one as an intervention block ($n = 3$) and one as a control block ($n = 3$; Figure 1). All clusters from the intervention and control blocks and all middle schools within these clusters were included in the study. Given our examination of adoption, implementation, and reach, we focused our analyses in this paper only on intervention schools. The findings presented are based on self-reported checklists—assessing intervention adoption, implementation, and reach—recorded by Cluster Coordinators and Headmasters in the intervention blocks.

Study Sample

The study sample included 219 schools from 46 clusters within the three blocks randomly assigned to the intervention arm. One block included 24 clusters, while the other two included 12 and 10, respectively. Cluster size ranged from two to seven schools each, with an average of 4.8 schools per cluster.

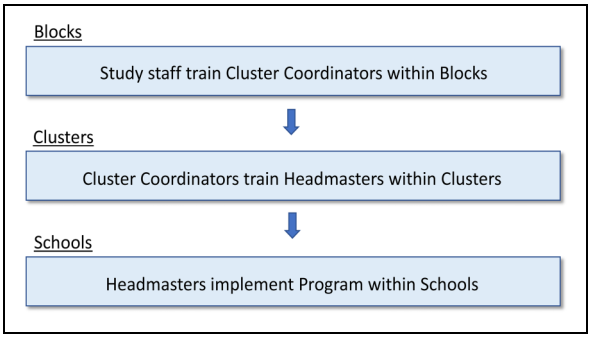
Evidence-Based Intervention: The *Tobacco-Free Teachers, Tobacco-Free Society* (TFT-TFS) Program

TFT-TFS is a school-based program conducted in person during school hours. The school Headmaster (or designee) delivers four TFT-TFS program components designed to establish a tobacco-free school environment. Program components incorporate six themes; the Headmaster delivers approximately one theme per month to teachers (Table 1). These six themes include: (1) Teachers as Role Models; (2) Health Effects of Tobacco; (3) Motivation to Quit—or Help Others to Quit; (4) Skills to

Table 1
Tobacco-free teachers, tobacco-free society (TFT-TFS) intervention activities and training-of-trainers (TOT) implementation components

TFT-TFS intervention components	Intervention activities	TOT implementation level	Implementation components
Group discussions with teachers about tobacco	Headmasters facilitate monthly discussions with teachers, centered on the six program themes	BLOCK	Study staff train, support, and provide program monitoring guidance to Cluster Coordinators within blocks
Cessation support for teachers	Headmasters provide cessation support, including distribution of the TFT-TFS quit booklet to all teachers and refer tobacco users to government cessation resources	CLUSTER	Cluster Coordinators train, support, and provide program monitoring guidance to Headmasters within clusters
Thematic posters	Headmasters hang six posters reflecting the program themes, one per month	SCHOOL	Headmasters implement TFT-TFS with teachers in their schools, including monitoring and reporting
Tobacco policy	Headmasters adopt and post the school's tobacco control policy on a wall that is visible for the school community and visitors		

Figure 2
Train the Trainer Model



Quit; (5) Dealing with Withdrawal; and (6) Maintenance and Celebration.

Training-of-Trainers (TOT) Implementation Strategy Components

Across India, the state-level DOE selects programs and curricula and passes down new material, directives, and methodologies through districts and blocks to clusters. Cluster Coordinators routinely interact with school Headmasters within their cluster, and train Headmasters to transfer this new information to teachers in their respective schools.

We leveraged this TOT cascade model for training Cluster Coordinators to train Headmasters to implement the TFT-TFS program within their schools over one academic year (August 2018–April 2019; Figure 2). Training sessions were participant-centered and interactive, drawing on the tenets of adult and situated learning. Training curricula included elements of effective training (Vella, 2008), such as role plays, group discussions, and opportunities for behavioral rehearsal and feedback (Koo & Miner, 2010; Lawson, 2009). Training content focused on (1) orienting participants to TFT-TFS themes and components and (2) building skills to implement the program. Training sessions included guidance on how to complete and return the process tracking checklists (Table 1).

Block level: Cluster Coordinators meet monthly to discuss administrative and curricular issues under Block Education Officer guidance. We worked with Block Education Officers to schedule TFT-TFS trainings for Cluster Coordinators. For one block, we conducted six monthly trainings. Due to Cluster Coordinator schedule constraints for the other two blocks, we combined trainings five and six and delivered them in the sixth monthly training. Each training was approximately 1 hr long, with an extended first training to orient participants to the TFT-TFS program. A senior study team member led the training.

We provided Cluster Coordinators with standardized training and program materials, which included a training manual for Cluster Coordinators; a TFT-TFS program Implementation Guide for Headmasters; TFT-TFS self-help quit booklets (enough for every participating teacher); one set of six thematic posters per school; and monthly process tracking forms ("checklists") for Headmasters to fill out and submit to Cluster Coordinators each month. Based on formative research and DOE feedback, the materials were revised to: accommodate 1-hr sessions (one per theme); emphasize the science base on which the program was built; and rely more heavily on the expertise of Cluster Coordinators to train Headmasters to implement the program in their schools.

Cluster Coordinators who were not present at the trainings picked up program materials at the Block Resource

Table 2
Definition, operationalization, and data collected for adoption, implementation and reach outcomes

Outcome	Definition	How operationalized	Data collected
Adoption	Headmaster attending at least one of the six cluster-level monthly trainings	Headmasters return of at least one of six monthly checklists	194 returned at least one checklist
Implementation	A school implementing all four core *Tobacco-Free Teachers, Tobacco-Free Society* (TFT-TFS) program components	Headmaster checklist data used to code schools as having successfully implemented the program if: (1) the tobacco policy was posted or displayed in the school; (2) the TFT-TFS cessation quit booklet was distributed to teachers; (3) discussions with teachers addressed at least three of the six program themes; and (4) at least four of six wall posters were hung	112 schools had sufficient checklist data to assess program implementation and implemented all four program components
Reach	Among schools that implemented TFT-TFS, a school had at least 80% of teachers participate in group discussions covering three or more of the six TFT-TFS program themes	Headmaster checklist data used to determine the number of teachers who participated in each group discussion divided by the number of teachers in the school	78 schools

Center and reviewed them with a study team member during a 10- to 20-min phone call.

Cluster level: Cluster Coordinators trained Headmasters during regularly scheduled monthly meetings. During the first training, Cluster Coordinators presented an overview of TFT-TFS and provided Headmasters with the program material. Cluster Coordinators were encouraged to work with Headmasters to troubleshoot any issues that might arise and complete process tracking checklists to record program activity in schools.

School level: Headmasters implemented the four core TFT-TFS program components with teachers in their schools.

Data Collection

Building from BSTS, we used self-reported checklists to measure program adoption, implementation, and reach. At the school level, Headmasters completed a monthly checklist to capture completed intervention activities (by marking a "yes" or "no"). Headmasters also recorded the number of teachers who attended each group discussion. Cluster Coordinators asked Headmasters to complete their monthly checklists immediately after delivering each program module to teachers in their schools, and collected checklists from Headmasters at the subsequent monthly training. Study staff reminded Cluster Coordinators to collect these reports before the next block-level training and collected Cluster Coordinator and Headmaster checklists from Cluster Coordinators at these monthly meetings. At the block level, Cluster Coordinators signed an attendance sheet and study staff recorded the number of Cluster Coordinators who attended. At the cluster level, Cluster Coordinators completed monthly checklists indicating if they conducted the monthly training for Headmasters; and how many Headmasters attended each training.

Measures

Guided by RE-AIM (Glasgow et al., 1999), we defined our measures as follows. *Adoption* was defined as the Headmaster attending at least one of the six cluster-level monthly trainings. However, because Cluster Coordinators are not required to collect attendance by school identification number, we could not track individual school participation across trainings; the Cluster Coordinator checklist only included the total number of Headmasters participating in each training. In response, we used an alternative measure of adoption, defined as completing at least one checklist. We used the maximum percentage of schools that attended each training. The percentage of schools attending within each cluster was estimated as the greatest number that attended any one of the trainings divided by the total number of schools in the cluster.

Among schools that adopted the program, *implementation* was defined as a school implementing all four core program components and measured dichotomously, that is, successfully implemented versus inadequately implemented. We used Headmaster checklist data to code schools as having successfully implemented the program if: (1) the tobacco policy was posted or displayed in the school; (2) the TFT-TFS cessation quit booklet was distributed to teachers; (3) discussions with teachers addressed at

Table 3
Number, percentage, and 95% confidence intervals for cluster coordinators and headmasters participating in trainings, based on cluster coordinator checklist data

Training	Cluster coordinators attending block-level training ($n = 46$)	Cluster coordinators offering cluster-level training ($n = 46$)	Schools represented at cluster-level training ($n = 219$)
Teachers as role models	45 (98%)	45 (98%)	210 (95.9%, 90.4–98.1)[a]
Health effects	41 (89%)	37 (80%)	186 (84.9%, 75.1–91.4)[a]
Motivation to quit	45 (98%)	30 (65%)	139 (63.5%, 52.6–73.5)[a]
Skills to quit	44 (96%)	31 (67%)	153 (69.9%, 60.1–78.5)[a]
Withdrawal	36 (78%)	30 (65%)	144 (65.8%, 54.8–75.4)[a]
Maintenance	28 (61%)	24 (52%)	123 (56.2%, 45.0–66.6)[a]

[a]Controlled for block.

least three of the six program themes; and (4) at least four of six wall posters were hung.

Among schools that implemented the program, *reach* was defined as a school having at least 80% of teachers participate in group discussion sessions covering three or more of the six TFT-TFS program themes. Reach was measured as the mean proportion of teachers who attended the monthly group discussions in each school. We used Headmaster checklist data to determine the number of teachers who participated in each group discussion divided by the number of teachers in the school (see Table 2).

Data Analysis

This study was designed as a non-inferiority study. We hypothesized that implementation of the TFT-TFS program would not be inferior to the original program tested in BSTS if at least 80% of the schools met each of the RE-AIM criteria of adoption, implementation, and reach. The unit of analysis was the cluster, as it was the unit of intervention delivery. The unit of measurement was the school. We used generalized estimating equation (GEE) methods, with the cluster as a random effect and the block as a fixed effect. In this non-inferiority study, the null hypothesis was that TFT-TFS program adoption, implementation, and reach would be inferior to the 80% benchmark set by the original program. Rejection of the null hypothesis led to the conclusion that the current program is not inferior to the original program. The null hypothesis was rejected for an outcome if the upper limit of the 95% confidence interval was greater than 80%.

For *adoption*, we used GEE methods to compute the mean percentage and the 95% confidence interval controlling for block as a fixed effect. We calculated the percentage of schools that met the *implementation* outcome and the 95% confidence intervals, controlling for the clustering of schools within clusters, and clusters within blocks. Using data from schools that implemented the program, we computed the mean percentage that met the *reach* outcome and the 95% confidence interval, controlling for the clustering of schools in clusters and clusters in blocks. We used SPSS v. 25 for all data analysis (IBM Corp, 2017).

Missing Data

If all Headmaster checklists were missing for a school, that school was excluded from the analysis of implementation and reach. If some checklists were missing and there was not enough information to confirm that the school met or did not meet the minimum standards for implementing one of the four program components, the school was coded as "missing" that component. If the information on one or more of the program components was missing, overall implementation was coded as "missing."

Results

Training of Trainers

Process tracking data documented: (1) if Cluster Coordinators conducted trainings for Headmasters and (2) Cluster Coordinator and Headmaster participation in their training sessions (Table 1). Study staff conducted 16 out of 18 planned *block-level* monthly trainings for all Cluster Coordinators. The median block-level training participation of the Cluster Coordinators across the 16 training sessions was 93%.

Cluster Coordinator checklist data revealed waning training participation over time. The percentage of Cluster Coordinators who reported conducting *cluster-level* monthly trainings for Headmasters was very high for the first training (98%) but declined to 52% by the last training. Similarly, Headmaster participation in these cluster-level trainings was high for the first training (96%) but declined to 56% by the sixth training. The median participation rate of Headmasters over the six training sessions was 68%.

Table 4
Number, percentage, and 95% confidence intervals for schools implementing all four program components and individual program components, based on headmaster checklist data

Component	Number of schools with complete data N (%)	Number of schools that completed a component		
		n	%[a]	95% CI[a]
All four program components	112 (58)	112	100	—
Individual program components				
Posted tobacco control policy	193 (99)	191	99.0	[98.2–99.7]
Distributed booklets to teachers	191 (98)	190	99.9	[96.9–1.00]
Conducted at least three group discussions	153 (78.9)	153	100	—
Hung at least four posters	113 (58)	112	99.1	[97.6–99.9]

[a]Controlled for block and cluster.

Program Adoption

Program adoption was assessed using training participation data provided by Cluster Coordinators. Among the 219 schools, 95.9% (CI = [90.4–98.1]) of Headmasters attended at least the first training (Table 3). It is possible that adoption might be higher than 95.9%, but we were not able to track individual school participation across trainings. Based on these data, we reject the null hypothesis that the program adoption rate is less than 80% and conclude program adoption met our non-inferiority target of 80% for those who attended at least one training.

Program Implementation

Program implementation was assessed using activities reported on the Headmaster checklist. Of the 219 study sample schools, 194 Headmasters (89%) returned at least one checklist. Of the 194 schools for which we have at least one checklist, 82 (42%) did not provide sufficient information for us to assess whether they had met the minimum standard for implementation. Among the 112 schools (58%) with sufficient information, all of them (100%) met the minimum standard for program implementation (Table 4). The table also shows implementation of the individual program components based on available checklist data for each school. There was adequate information to assess the posting of the tobacco policy and distribution of quit booklets, both of which had high implementation rates at over 96%. However, for a large proportion of schools, there was inadequate information to assess whether schools hung multiple posters or conducted multiple group discussions. Yet, for the 112 schools with adequate information on these program components, implementation rates were similarly high. Again, we reject the null hypothesis that program implementation is lower than our 80% benchmark.

Program Reach

Program reach was measured using data from the Headmaster checklist and among those schools that met the minimum standard for program implementation, that is, implementing all four of the TFT-TFS program components ($n = 112$). Teacher participation rates in the monthly group discussions among these schools ranged from 6% to 100% ($M = 82\%$, $SD = 23\%$). Seventy-eight of the 112 schools (69%, 95% CI [69.3–70.0]) met the criteria for reach. The upper limit of the confidence interval is less than 80%, therefore we cannot reject the null hypothesis that TFT-TFS program reach was inferior to our benchmark.

We hypothesized that less than 80% of the schools would meet the criteria of adoption, implementation, and reach. This null hypothesis was rejected for adoption and implementation but was not rejected for reach. Therefore, we concluded that the current TFT-TFS program was not inferior to the original program in adoption and implementation.

Sensitivity Analysis

We were unable to fully assess implementation for many schools. Thus, we conducted a sensitivity analysis for that outcome, assuming that all the schools with insufficient information did not meet the minimum implementation standard. If we assume that all 82 schools with missing data did not meet the implementation standard, then the percentage meeting the implementation outcome is 57.7% (95% CI [56.9%–58.6%]). In this case, we would fail to reject the null hypothesis and conclude that the implementation rate was inferior to our benchmark rate of 80%.

Although our estimate based only on schools with sufficient checklist data may be overly optimistic, the estimate based on the assumption that all incomplete data indicated no activity is likely too pessimistic. Among the 81 schools with inadequate information for assessing whether they

hung four posters, 35 hung one poster, 9 hung two, and 37 hung three. Similarly, among the 41 schools with inadequate information to assess whether they conducted three discussion sessions, 33 conducted one session, and eight conducted two sessions.

Discussion

The goal of this study was to determine the extent to which a cascade TOT implementation strategy, embedded into the existing DOE infrastructure, would meet acceptable rates of TFT-TFS program adoption, implementation, and reach among schools in Bihar. Overall, our training strategy was conducted as planned, and Headmasters implemented the program—in part or in full—in their schools. For adoption, nearly all Headmasters attended the first training. For the 112 schools where we have complete Headmaster checklist data, all of them met our minimum criteria for implementing the program. Only 69% of schools met our criteria for program reach. We believe this study advances practice and contributes to the evidence base of using a TOT approach and the government infrastructure to embed tobacco control interventions in schools—a strategy that can be applied to other health EBIs in low-resource settings.

Adoption

We found that 96% of Headmasters attended at least one TFT-TFS training session. However, this number may be higher since some schools may have attended the second training but not participated in the first. We purposefully selected a minimum level of adoption (attending at least one training) to allow us to capture the maximum number of schools that received at least an introduction to the TFT-TFS program. Complete program implementation instructions were provided to Headmasters who attended at least one training, to equip them to deliver the full program in their schools independently.

Several factors may have contributed to this high level of adoption. First, we built a strong rapport and buy-in with DOE officials during study preparation. The DOE permitted us to tag an hour onto the end of a routine monthly meeting of Cluster Coordinators, and in turn, for the Cluster Coordinators to train Headmasters in conjunction with regularly scheduled meetings. Second, a locally based physician and tobacco control expert served as the lead trainer of Cluster Coordinators and liaison to local-level officials and school leadership; reputable leaders who understand the local context are likely to increase program credibility. Third, leveraging regular Cluster Coordinator/Headmaster meetings may have reduced obstacles to Headmaster attendance. Although the reasons for declining attendance over time are not clear, our findings suggest that fewer trainings may be needed to cover material and maintain program momentum. Fourth, developing a TOT model with 1-hr monthly sessions (instead of a multiday training) was designed to facilitate adoption and was a strategic response to the reported strain on education personnel, who deliver an array of mandated programming alongside their routine teaching workloads. Finally, the training materials were developed with DOE input and pretested with a cohort of Cluster Coordinators and Headmasters outside of the study sample before roll-out.

Implementation

All schools with sufficient checklist data reported meeting at least the minimum standard for program implementation. Because implementation is a composite score of implementing all four TFT-TFS components, we did subanalyses of each component. We found that more than 96% of schools posted the *tobacco control policy* and distributed the *quit booklet* to teachers.

For the six *group discussions*, 153 of schools—almost 80%—conducted at least three of the six discussions. This suggests that after participating in trainings, Headmasters understood the importance of group discussions and convened these gatherings with teachers in their schools. Core to implementation, these discussions were designed to: disseminate information about tobacco facts, myths, and harms to teachers; and allow teachers to reflect on the themes, apply the content to their lives, and use the knowledge and skills gained to promote cessation in their schools and communities.

Finally, we believe schools may have encountered challenges in hanging the six monthly *themed posters* due to concern over their durability through rainy weather, for example. Many schools do not have boundary walls, and Headmasters expressed concerns that posters hanging in public places would be stolen or vandalized. Accordingly, in most schools, the posters were hung in the Headmaster's chambers or the teachers' room, which limited their visibility.

Reach

Only 69% of the schools met our reach criteria. In Bihar, there is typically a fixed time for teachers to meet with Headmasters on different subjects. Through Headmaster feedback, we learned that many schools treated tobacco as one of these subjects, which may have helped embed TFT-TFS discussions into the natural flow of school operations. Additionally, Headmasters often held discussions on Saturdays in conjunction with Chetna Satra (a regular morning assembly with students) and with parent–teacher meetings, resulting in the spread of program information to students and the broader community.

Despite these efforts to embed TFT-TFS discussions into routine meetings, teaching demands, and other time-bound priorities may have precluded the fullest scope of

teacher participation. Competing priorities of teachers are a universal challenge; a 2017 assessment cited similar constraints to teacher participation in a tobacco cessation study in Vietnam (VanDevanter et al., 2017). Teachers may have also felt that they received enough program content in early trainings to help others quit without having to attend later sessions, similar to other studies (Santos et al., 2017). Furthermore, despite our efforts to make the program content meaningful to tobacco users and non-users alike, we heard anecdotally from some non-tobacco-using teachers that they felt the program had limited relevance.

TOT Model

Our choice to use a TOT model is well supported by other investigators. In India, Chabbra et al. successfully employed a TOT model to implement an HIV/AIDS and alcohol education program in schools in Himachal Pradesh (Chhabra et al., 2010). Nyamathi et al. found improvements in HIV knowledge among nurses in Delhi (2008) and health care providers in Maharashtra were successfully trained to respond to women facing violence through a TOT approach (Gaddappa et al., 2021).

Investigators used a cascade training model to scale a diabetes prevention program in Kerala (Ravindranath et al., 2020) by training trainers from a women's health organization to train peer leaders to implement 12 monthly sessions. Like our study, 98% of peer leaders reported conducting at least one session, with session delivery declining to 74% of all 12 sessions. Our decision to train lay people was also supported by investigators who used a TOT model to train lay first responders in Sierra Leone and South Africa (Eisner et al., 2020; Sun & Wallis, 2012). However, our approach differs from these studies in two ways: First, these models utilized 1- to 5-day trainings, versus our approach to train Cluster Coordinators each month before their regular monthly meetings with Headmasters. Second, we did not conduct pre- and post-knowledge assessments, in part because we trained Cluster Coordinators monthly and focused on assessing their training of others to implement the program.

Limitations

While this study used a rigorous evaluation system to track TFT-TFS adoption, implementation, and reach, we were limited by the responses within the checklists. For example, we were only able to track the total number of schools that attended each training and could not link individual school participation across trainings. Reliance on evaluation data self-reported by Headmasters regarding implementation of the program in their schools is also a significant challenge. Of particular concern is the missing data from schools participating in the program. It was not possible to determine if data were missing because Headmasters did not return their checklists because they did not attend trainings, or for other reasons. Also, sensitivity analyses suggest that, although schools failed to return a sufficient number of checklists to determine the implementation of group discussions and hanging posters, these schools nonetheless reported implementing at least some program activities. Additionally, self-reporting can result in a potential social desirability bias. Headmasters may have been reluctant to record that they did not implement all program components and Cluster Coordinators may have over-reported the number of trainings conducted. Ravindranath et al. also noted reliance on self-reports and the potential for "reporting of more positive outcomes" as a limitation of their study in Kerala (2020). We saw substantial variation in training and implementation numbers across TFT-TFS, so this may not have been a major concern. Future research should consider using digital program tracking on mobile devices, free online options such as Google docs, or embedding tracking into existing school data collection platforms to mitigate this bias.

This research highlights the critical nature of leadership support (Zomahoun et al., 2019), as evidenced by the levels of training participation. However, while we had DOE support, there were no DOE mandates to conduct these activities, nor direct DOE supervision, making training and program implementation somewhat voluntary.

The generalizability of these findings also has some limits. The DOE training structure in Bihar was well suited for implementation, but we cannot generalize the suitability of implementing this EBI across other LMIC contexts with different structures, nor for school systems lacking supportive DOE structures. Additionally, our analyses cover implementation over only one academic year, prohibiting us from commenting here on program maintenance or long-term sustainability.

Strengths

This study offers valuable evidence for applying a TOT model as a tool in scaling up tested tobacco control interventions in collaboration with an education department. By design, we included several rural and urban blocks and clusters to demonstrate how our TOT strategy and TFT-TFS implementation could work in diverse, real-world contexts. We also complemented the Government of India's tobacco control efforts, which are outlined in the Guidelines for Tobacco Free Educational Institutions (ToFEI; Ministry of Health and Family Welfare, 2019). Specifically, state and national governments mandate that teachers not use any form of tobacco in schools and restrict tobacco use in and around school boundaries, but provide no formal programming for teachers, nor teacher-level discussions. Jalaluddin also recommended an approach similar to TFT-TFS of involving all teachers and providing support to Headmasters' school health programs in India (1991). Thus, the TFT-TFS program—in providing

teachers with skills to quit and to support others who want to quit—helps advance government anti-tobacco efforts in Bihar and India.

Finally, our study contributes to the evidence-base of using RE-AIM in LMIC contexts. Similar to Onomo and colleagues, the RE-AIM framework helped us plan out each component of our implementation strategy (Onono et al., 2018). However, unlike other investigators, our definition of adoption and reach did not overlap since both were school-level variables (Aziz et al., 2018; Gaglio et al., 2013). We concur with Bauman et al. that while RE-AIM helped us conceptualize our implementation outcomes, it did not capture the sociopolitical contextual factors crucial to implementation success (Baumann, 2020).

Future Implications

This study has important implications. Follow-on research may look more closely at adapting TFT-TFS to various contexts and examine the minimum amount of support needed to implement the program. The methods and processes used to develop this intervention for tobacco control can also be used to address the growing burden of noncommunicable diseases (NCDs) in LMICs. We recently developed the implementation manual into a self-directed guide, leading future investigation to explore how well this works in practice. Additional research may also examine contributors to program maintenance and sustainability, which could not be adequately assessed here due to the COVID pandemic and related school closures.

This study also pointed to a common challenge for implementation research: the reliance on process evaluation data to track program implementation. With increasing use of community members as program implementers, it is necessary to rely on their reports of program implementation. Future investigations will benefit from increasing attention to the need to validate these self-reports and accurately track program implementation.

Finally, this study underscores the need for ongoing attention to the implementation of public health efforts in low-resource settings. Future research is also needed to design and test implementation methods that are responsive to the setting and adaptable to the available resources.

Conclusions

This study outlines the processes for taking an evidence-based tobacco control intervention to scale and implementing it through readily accessible and sustainable government channels—in this case, a state DOE infrastructure. These findings provide a foundation for other state governments in India and other LMICs to adopt this tobacco control EBI for school teachers. Given the few studies applying RE-AIM in LMICs, this study makes a valuable contribution to the literature by demonstrating the effectiveness of this training model. Our findings underscore that program implementors need training and support to fully implement a program that is sensitive to their time and other priorities. Leveraging existing meetings also helped embed the program into routine activities. Additionally, this same capacity-building and implementation strategy can be used to scale the ToFEI guidelines and other public health-related EBIs in resource-constrained areas. Engaging teachers as role models to promote health can have a significant impact in many contexts within and beyond India.

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ORCID iD

Eve M. Nagler https://orcid.org/0000-0002-8661-178X

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