ORIGINAL ARTICLE

IMPARTING TUBERCULOSIS (TB) LITERACY USING A YOUTH-FRIENDLY PUZZLE GAME - A PILOT QUASI-EXPERIMENTAL STUDY, TAMIL NADU, 2022-2023

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ABSTRACT

INTRODUCTION : Considering the lack of participatory awareness interventions to enhance TB literacy, we co-created and implemented a TB puzzle game for adolescents and assessed its impact on TB knowledge. We aimed to co-create and implement a TB puzzle game-based intervention study in the private schools of Chennai, an Indian megacity, to impart TB literacy to adolescents and evaluate its outcomes in terms of TB literacy.

METHODS : We utilized the PRODCUES framework to co-create a crossword puzzle game to impart TB literacy. We used a quasi-experimental design to evaluate its usefulness in improving TB literacy among high school students in a metropolitan city. The study involved 11th and 12th-grade school students from Chennai who were divided into intervention and control arm. A TB crossword puzzle was used to impart TB literacy in intervention arm A and TB awareness pamphlets were used for the same in control arm B. A total of twenty engaging puzzles were developed which were related to 1) Interesting facts about TB (fig. 1.1), 2) Symptoms of TB (fig. 1.2), 3) Dos and Don'ts for TB (fig. 1.3), and 4) Treatment of TB (fig. 1.4). Puzzles were developed with an engaging and easy-to-follow language style. Puzzles were interlaced with hints to intrigue the participants to solve them using relatable concepts and facts. TB literacy levels were measured using a standardised scale before and after the intervention in both arms.

RESULTS : The baseline TB literacy scores in intervention arm A and control arm B were 15 (IQR 14, 18) and 6 (IQR 4, 7) respectively. The average score of completion of TB crossword puzzles out of 20 was 17 (max 20 and min 4) and was completed in 20 minutes on average.

CONCLUSION : The improvement in TB literacy achieved through game-based puzzles was found to be much higher among students as compared to routine IEC intervention.

KEYWORDS : Literacy, Puzzle, Intervention, Tuberculosis, Students, Games

INTRODUCTION

Public health interventions for the younger age population are considered important as they are helpful to improve awareness and knowledge on health-related issues. Especially Information Education and Communication (IEC) intervention for improving awareness and knowledge on important public health issues among the young age population has the potential to bring in positive behavior change at an early stage of life. Structured IEC interventions also help to evolve preventive health measures among the young age population, especially in settings like schools and colleges where they could be accessed easily in an organized way.[1] India accounts for one-fourth of the global tuberculosis (TB) burden, of which 10% is suffered by children and 32% burden by the age group between 15-29.[2] Despite the decade-long efforts to generate awareness about TB, still, TB remains a mostly misunderstood and stigmatized disease. The basic knowledge and literacy about TB have remained low which in turn leads to poor health-seeking behavior and delays in care.[3]

Public health intervention to improve TB literacy among young adolescents and the young population has not received sufficient attention in India. There has not been sufficient focus on age-specific IEC intervention for TB in general. Few interventions that were conducted in research mode among school students have shown that age-appropriate IEC intervention could improve TB knowledge.[4,5] However, the limitation of the present interventions to improve TB awareness in India and globally was that all these interventions were provider-driven and lacked self-

participation and agency from the learners or subjects. Such a provider-driven approach could be the reason that most TB awareness interventions are not sustained in the long term and lead to poor TB awareness levels in the community in the long run. Hence there is a felt need to develop and test a participatory intervention for improving TB literacy which would be driven by the agency of the learner i.e. the community at risk and vulnerable to TB which is more driven by their interest and demand. In this background, we aimed to develop a puzzle game-based activity

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METHODS

The ethics committee of the School of Public Health, SRM Institute of Science and Technology, Tamil Nadu had approved this study which was aimed at evaluating a TB puzzle-driven awareness intervention in high school settings. Between June 2022 and June 2023, we implemented and evaluated a participatory game-based TB puzzle intervention to improve TB knowledge among students in the private schools of a metropolitan city, in South India. This study was conducted among high school students who were aged 14-17 years and presently enrolled in 11th and 12th grade in a registered school in the city. School students at this age were chosen considering the need for developing age-specific TB IEC interventions in the study setting. The study primarily aimed at evaluating the preliminary efficacy of a game-based intervention for improving TB treatment literacy and secondarily assessed the designing and implementation aspects of this first-of-kind game-based intervention in the TB awareness context.

Intervention designing

We used the PRODCUES framework (Problem Exploration, Objective Intervention implementation Design, end Users, Co-creators, Evaluation, and Scale-up) for prioritizing the research problem and further designing the game-based intervention study (Table 1)

Problem Exploration and identification:

As a first step, the study team undertook a desk review of the gaps in the existing TB IEC intervention for adolescents and youth. A team of researchers, including experienced social behavioral researchers, social workers, teacher and students with expertise and exposure in outreach activities and conducting intervention studies among school students, collaborated to develop TB awareness interventions through discussions and brainstorming sessions on the barriers and challenges in imparting TB literacy for the younger age population, especially to school students. With a literature review and shared experiences of experts and intended beneficiaries (TB patients of different ages) it was identified that the conventional IEC interventions for TB are not age-specific in India. All the available IEC interventions for improving TB literacy were provider-driven and lacked self-participation and agency from the learners or subjects. During the formative phase, a series of informal interviews and discussions were done with TB researchers from the institute, TB program workers part of NTEP, school teachers, and students of a few selected schools to get insights about their needs, preferences, dislikes likes, and barriers in terms of health literacy concerning TB. Inputs were gained about the different forms of TB sensitization, messages, and the different modes of communication and engagement were inquired, and explored. Proposed new types of TB literacy communication and interventions were inquired and their relevancy based on field adaptability and resource constraints were assessed.

Objective setting and Intervention Designing:

Based on the insight from the explorative phase, it was concluded that developing participatory & engaging crossword puzzle-based games for imparting TB literacy would be a rational choice. It was aimed to develop this puzzle game to have the features of built-in motivation concepts and rewarding experiences for the subjects.

Crossword puzzles are a widely recognized form of the game which is played across all age groups including the young population. The puzzles are playable and don't involve many resources for either the provider and also the gamers. Crossword puzzles are known to have the attributes of nurturing interests in a particular topic of puzzle and stimulating motivation and curiosity about the subject while solving the puzzle which in this case is about TB. Solving a puzzle also remains an in-built rewarding phenomenon for gamers. It also concurred that crossword puzzles can improve the student's ability to focus and their working memory towards the topic of interest i.e. TB literacy. It was also observed that TB literacy which comprised of categorical factors about TB could be easily adopted in the form of crossword puzzles.

A proof-of-concept crossword puzzle game that could be played using a puzzle interface was developed with gaming principles and features. Further, a series of co-creation exercises were undertaken to develop a game

that would be appropriate for adolescents and youngsters and which would fulfill the criteria of the objectives. We conducted three co-creation and consultation workshops with the student community, TB researchers, and teachers to evolve a TB puzzle game iteratively.

A total of twenty engaging puzzles questions were developed which were related to 1) Interesting facts about TB (fig. 1.1), 2) Symptoms of TB (fig. 1.2), 3) Dos and Don'ts for TB (fig. 1.3 and 4) Treatment of TB (fig. 1.4). Puzzles were developed with an engaging and easy-to-follow language style. Puzzles were interlaced with hints to intrigue the participants to solve them using relatable concepts and facts.

Intervention Evaluation:

We used a quasi-experimental design in which we provided a crossword puzzle-based intervention to engage and educate the students on TB literacy in comparison to a routine TB-IEC pamphlet-based intervention.

For the study, we selected 11th and 12th-grade students from English medium classes at two private schools in the city. Of the four classes selected, two classes were allocated as intervention arm A in which the crossword puzzle was used. The other two classes were allocated as intervention arm B in which TB-IEC pamphlets were used which contained the same facts and information as the TB crossword puzzle but in a narrative paragraph form in English. We enrolled 50 students from each of the four classes based on the willingness of the students. As the study was conducted as part of the routine educational activity oral consent was obtained from students and teachers.

To avoid spillover and contamination between intervention arm A and B classes were engaged separately in terms of place and time. Each enrolled student was provided a Unique ID and the purpose of the study was explained beforehand as per the intervention status (A or B).

Implementation of puzzle game:

A team of two researchers (trained social worker with master's degree in Social Work and student trainees pursuing Masters in Public Health) along with class teachers, explained to the students in the intervention arm A, that they would be given a crossword puzzle sheet with four puzzle pages which would have a total of 20 questions. Students were instructed to try to complete these puzzles by themselves and by using the hints which are given beneath the page. Students were explained that this was not a test to check their ability to solve puzzles but only to create awareness about an important public health problem in the country. Students were requested not to discuss with others about puzzles and were monitored by the class teacher. A time period of 30

minutes was given for the students which was extended for individual students as requested. After this, the students were asked to stop the activity. Further, the researchers made an interactive session with the students to know their level of engagement and answers to the puzzle. Answers to the puzzle were given to the students and they were asked to verify their responses. No marks were given but students were asked about the usefulness of the activity in knowing about TB and their feedbacks were noted. All puzzle sheets were collected back by the researcher at the end of the session.

Implementation of standard IEC intervention using a pamphlet:

A similar team of researchers and class teachers explained to the students of the intervention arm B that they would be provided an information pamphlet about infectious disease and they were requested to read the pamphlet individually. The pamphlet consisted of all the information and facts about TB which the TB puzzle game had but in the form of an essay. Students were asked to take 30 minutes to read the pamphlet. Post the reading session a discussion was conducted by the researchers on the content of the pamphlet and students were asked to clarify their doubts about TB and related facts. A duration of 30 minutes was used for this intervention.

Intervention evaluation:

Before the initiation of the intervention on both arms, initially, students were asked to undergo a test on TB literacy using a standardized tool which consisted of 13 Multiple-choice Questions on TB symptoms, preventive measures, treatment aspects, risk factors, diagnosis, etc. The total score of the tool was 20 with maximum weight given to the TB symptom-related questions. Students were provided 15 minutes to complete the TB literacy test and further the intervention was provided in both arms as follows. After completing the intervention, an end-line assessment was conducted using the same TB literacy tool after a 15-day interval. This timeframe allows students sufficient opportunity to reflect on the training content and engage in discussions with peers or family. The 15-day gap also serves as an initial measure of the training's effectiveness in fostering sustained awareness. Post activity the teachers and students were provided the softcopy of the puzzle and pamphlet for further reference and use.

Sample size:

The sample size was calculated based on the estimate of overall TB literacy level as 30% and expected an absolute increase in TB literacy level following the puzzle intervention by 20% and a percentage difference of 50%. With an

assumed alpha value of 0.05 and power of 0.80, the sample size estimated was 190 which was rounded to 200 with 100 in the intervention A and Intervention arm B.

Data collection and Statistical analysis:

All data were collected in questionnaires and puzzles were also given in paper format. For each student age, gender, and class of study was collected along with TB literacy information. Data were compiled using Excel and analyzed using STATA crop 15.1.

Participants' characteristics and intervention uptake were described using frequency, mean, median, IQR, and standard deviation. Tests of normality were conducted to the distribution of outcome variables (i.e. TB literacy) Two-sample Wilcoxon rank-sum (Mann-Whitney) test was used to test for a significant difference in TB literacy between the two groups (who underwent TB puzzle as compared to those who underwent TB pamphlet exercise). Wilcoxon signed-rank test was used to test significant differences within the same groups before and after intervention. The effect size which is the magnitude of difference in the TB literacy scores resulting from the two interventions A (crossword puzzle-based intervention) and B (pamphlet-based intervention) was calculated and significance was reported at 0.05 level of significance.

RESULTS

A total of 200 students were enrolled in the study of which 100 were in the intervention arm A (for TB crossword puzzle) and 100 in the intervention arm B (standard IEC intervention using pamphlet) from four classes of two different private girls' educational institutions from the city. Of the 200 students, 100 were from high school grade and 100 were first-year graduate school. All the students were of female gender.

Table 1: Steps used for intervention development using the PRODCUES framework

Problem Exploration and identification	Conventional IEC interventions for TB awareness and literacy are provider-driven and lack self-participation and agency. Lack of self-initiative and motivation toward public health literacy Involvement of public health experts in conventional IEC which are limited and resource-intensive
Objective	To develop a game TB IEC intervention which would be (I) Participatory & engaging for subjects, (2) Features In-built motivation concepts & rewarding
Intervention implementation Design, end) Users	Co-creation, students, researchers, TB patients, the general community, and program stakeholders
Co-creators	Adolescents, TB patients, students, researchers, teachers
Evaluation	Non-randomized experimental study to assess efficacy and implementation aspects
Scale up	Will be sustained in the implementation districts based on the study outcomes

Table 2 The mean age of the participants was 18 (min 14 to max 18). Of the total TB crossword puzzles (n=20), which were played by the students the average score of completion was 17 (min 4 to max 20) (SD 4.6). The median baseline TB literacy for the intervention groups A and B were 4 (IQR: 2, 5) and 3 (IQR: 2, 6) respectively, and end-line TB literacy scores for the intervention groups A and B were 15 (IQR: 14, 18) & 6 (IQR: 4, 7) respectively.

Table 2- TB literacy scores of students

Group	n	Test score Median (IQR)	
		Before	After
Intervention A (PB puzzle arm)	100	4 (2,5)	15(14, 18)
Intervention B (TB pamphlet arm)	100	3 (2,6)	6 (4, 7)

Table 3: Within and between-group comparison of TB literacy score among the participants.

	Within group comparison		
	Effect size	Z value	p-value
Intervention A	0.87	-8.7	<0.001
Intervention B	0.51	-5.22	<0.001
	Between-group comparison		
	Effect size	Z value	p-value
Baseline	0.02	-0.3	0.762
End line	0.87	-12.25	<0.001

Table 3 Wilcoxon rank-sum (Mann-Whitney) test showed that there was no significant difference in the baseline TB literacy score had an effect size of 0.02, z = -0.303, p = 0.762) between intervention groups A and B, but a significant difference was noted in the end line TB literacy score with an effect size of 0.87 (z = -12.2, p<0.001) between intervention arm A and intervention group B signifying improved TB literacy score among those who underwent TB crossword puzzle.

Wilcoxon signed-rank test shows a significant change in TB literacy score from baseline to end-line among participants who underwent standard IEC intervention using a pamphlet with an effect size of 0.51 (z = -5.1 p <0.001). However, participants who underwent the TB puzzle game had a larger change in literacy scores with an effect size of 0.87 (z = -8.7, p<0.001).

DISCUSSION

To our knowledge, this is the first game-based participatory intervention study in the context of imparting TB awareness and literacy in India. The results highlight a significantly high impact of TB puzzle-based games in improving TB literacy among adolescents and young students.

The effect size achieved through game-based puzzles was found to be much higher (0.87) as compared to (0.51) routine IEC intervention. The impact of the present TB literacy using puzzle games was found to be relatively higher as compared to another type of TB IEC intervention which was tested among the school population in India. For example, a study among school students using TB Ambassador achieved a 40-60% increase in TB literacy in a metropolitan city which was relatively lower than our estimates.[6]

Similarly, a simple intervention of using an essay competition as the mode of imparting TB awareness among school students was tested in 2010 (Vellore district) and was found to be effective only with a mean difference of 3-4%.[4] Another study conducted in Bangalore India used visual health education intervention with pictorial presentation and found that the TB literacy score increased from 8.77 % to 14.95 % from pre-education to post-education which was again a moderate effect. [7]

In addition to the effectiveness aspect, the TB puzzle intervention was different from other previously tested interventions in terms of its participatory and self-driven nature rather than a provider-driven teaching method. During the intervention implementation, we found a high receptiveness and demand from students towards playing the puzzle game as compared to the standard IEC intervention. Also, we found that all the participants completed the TB puzzle in 20 minutes which was less than the other school-based IEC interventions.

The successful designing and implementation of this puzzle-based intervention is a key finding of this study. Using the PRODCUES framework, we addressed gaps in existing TB IEC interventions for adolescents.

The co-creation process with TB researchers, teachers, and students ensured the intervention was relevant, age-appropriate, and engaging. The implementation showed feasibility, with active participation, timely completion (average 20 minutes), and no dropouts. These results demonstrate the potential of participatory, game-based interventions to improve health literacy in resource-limited settings.

The importance of game-based TB puzzle intervention was that each student was nudged in such a way that they participated in the intervention and completed it without dropping out in the middle. The combination of puzzles which combined disease information and general facts about TB using interesting probes made the entire exercise participatory and rewarding. The findings of this study need to be interpreted from a broader perspective in which games are being increasingly used for public health issues involving behavioral change, knowledge building, health care access and utilization, etc. Games are being recognized as vital tools that could improve participation and the self-driven interest of the community. Such features of games-based intervention are important for the suitability of community-based health interventions like TB awareness building. Also, games are less resource-intensive methods of activity due to their participatory nature and thus would be a feasible option for conducting mass-level public health interventions (like TB IEC intervention).

LIMITATIONS

This study was conducted as a quasi-experimental study in limited schools which could have led to selection bias of the population. But since the study was aimed as a proof of concept to estimate the preliminary efficacy such concerns were not considered.

Further to estimate the effectiveness of game-based intervention a larger cluster randomized trial could be a logical next step of this study. Another limitation of this study is that the tool used for data collection was developed with input from experts and designed to align closely with the study objectives was not formally validated prior to its application.

CONCLUSION

Imparting TB literacy through game-based intervention was feasible and resulted in significant improvement of TB literacy among adolescents in the present study. Game-based interventions could be of importance for imparting TB awareness to the younger age population. Adopting games to improve TB awareness and literacy at the mass level could be evaluated through large-scale community-based studies.

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CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

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