INT J TUBERC LUNG DIS 24(1):28–35

http://dx.doi.org/10.5588/ijtld.19.0161

Evaluating the use of educational videos to support the tuberculosis care cascade in remote Madagascar

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SUMMARY

SETTING: Access to information about tuberculosis (TB) is vital to ensure timely diagnosis, treatment, and control among vulnerable communities. Improved approaches for distributing health education materials to remote populations are needed.

OBJECTIVE: To evaluate the impact of two comprehensive video training curricula in improving patient, community member, and community health worker knowledge of TB in a remote area of Madagascar.

DESIGN: A pre-test/post-test design was used to measure knowledge acquisition. Educational videos were short, culturally appropriate films presented at critical moments in the TB cascade of care.

RESULTS: Of the total 146 participants, 86 (58.9%) improved their score on the post-test, 50 (34.2%) obtained the same score, and 10 (6.8%) received a worse score. A statistically significant difference was observed between the pre- and post-test scores, wherein scores increased by a median of 10.0% (interquartile range 0.0–20.0) after viewing the videos ($P < 0.001$). There was a significant difference between the number of correct answers on the pre-test and the number of correct answers on the post-test ($P < 0.001$).

CONCLUSION: Educational videos were found to significantly improve TB knowledge among a low-literacy, remote population in Madagascar. Our findings suggest educational videos could be a powerful, low-cost, and sustainable tool to improve access to TB education materials globally.

KEY WORDS: health education; TB case finding; rural health; electronic health; mobile health

LIVING IN A REMOTE location is a primary barrier to accessing timely and appropriate healthcare.[1] Accessing tuberculosis (TB) care can prove particularly challenging for remote populations due to geographic barriers and lack of infrastructure.[2,3] If TB symptoms are recognized, patients in these settings are often referred to distant health facilities for diagnosis and treatment.[4,5] As a result of the significant distances TB patients must travel, medication adherence and treatment outcomes can suffer.[3] In addition, remote populations are particularly difficult to reach, generally know less about the disease, and have lower levels of literacy.[3] In order to eliminate TB, it is essential for patients who develop the disease to have the necessary knowledge to prevent transmission to others. Furthermore, improved access to high-quality TB care for both TB patients and communities will be necessary for elimination.[6] There is sparse systematic research on methods and approaches for TB education in remote, low-literacy populations. Although there are often community health workers (CHWs) available to provide basic healthcare in remote areas, increasing awareness about TB remains a challenge.

Innovative technologies present one method for improving TB education across the cascade of care in these hard to reach areas.[7] Over the last two decades, rapid advances in health technology have increased access to healthcare for millions across the world. Information and communication technologies are used extensively to assist in the growth of electronic health (eHealth) and telemedicine. With two thirds of

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Article submitted 7 March 2019. Final version accepted 15 June 2019.

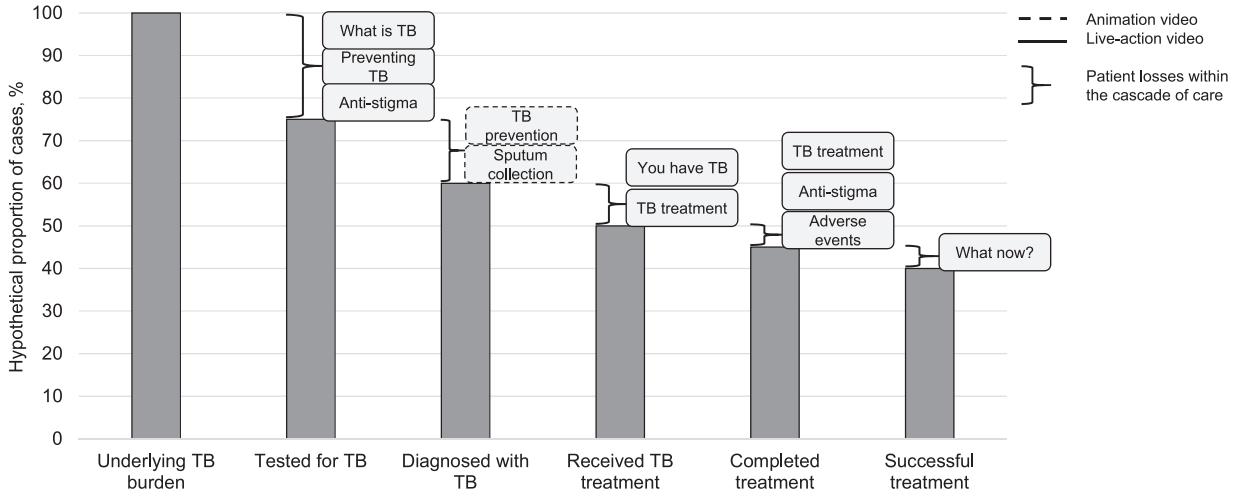

Figure 1 TB cascade of care with the implemented video training curriculum for TB patients, presumptive TB cases, and community members. Cascade is based on hypothetical proportions. TB = tuberculosis.

the world's population having access to mobile phones, mobile health (mHealth) strategies are being used worldwide.[8–11] This expansion of technology has fostered the creation and implementation of health-focused educational videos spanning a wide range of diseases and diagnoses, including reproductive health, glaucoma, foot care, schistosomiasis, human immunodeficiency virus (HIV), and the hepatitis C virus.[12–17] Most of the existing literature focuses on the effectiveness of health education videos for urban populations in high-resource settings; documented implementation and evaluation of videos in low-resource settings are limited. Scientific Animations Without Borders (SAWBO; Michigan State University, East Lansing, MI, USA) has evaluated videos on a variety of topics, including agricultural practices and health, in several sub-Saharan African nations.[18–20] Similarly, a TB sputum collection video produced by In Tune for Life (ITFL; London, UK & Geneva, Switzerland) was evaluated in Tanzania.[21] These studies show that using devices with pre-downloaded video content has been valuable in settings where internet or telecommunication are unavailable.

While TB informational videos are available online through the internet, few have been developed for use in low-resource settings. Although limited, assessments of videos targeted at improving knowledge of TB have been found to be an effective method of education.[21–25] While preliminary studies support the effectiveness of using TB educational videos to improve patients' knowledge, additional research is needed in diverse settings.[21–25]

The present study describes the impact of educational videos on patient, community member, and CHW knowledge of TB in remote areas of Madagascar.

STUDY POPULATION AND METHODS

Study population

The target population were individuals living in villages in the Androrangavola commune of the Ifanadiana District in south-east Madagascar. Populations in this area are extremely remote, living significant distances from health care facilities; villages are accessible only by foot and do not have access to cellular and common communication networks. Enrolled participants were aged ≥15 years and divided into four groups: 1) TB patients, bacteriologically confirmed; 2) presumptive TB cases, symptomatically but not diagnostically confirmed; 3) randomly selected community members; and 4) CHWs who provide basic health services in these villages.

Educational video training curricula on tuberculosis

Fourteen "live-action" videos were created and two locally adapted animated videos were used in this study. For the live-action videos, a team of National TB Program (NTP) doctors and nurses identified key messages to address gaps in the local TB cascade of care. Through an iterative process, video content was scripted, filmed, presented to local communities and improved based on feedback. Live-action videos were filmed within villages and relied on local NTP clinical personnel and stakeholders to deliver information in Malagasy, the local dialect. Videos were designed to mitigate the risk of patients dropping out of the TB cascade of care. The two animated videos, "TB Prevention" and "Sputum Collection," were created by SAWBO and ITFL, respectively (Figure 1). The content of the animated videos was developed by international TB experts in order to create scientifically accurate educational animations. Following versions customized to other settings, the videos were translated and voice-overlaid into Malagasy for this

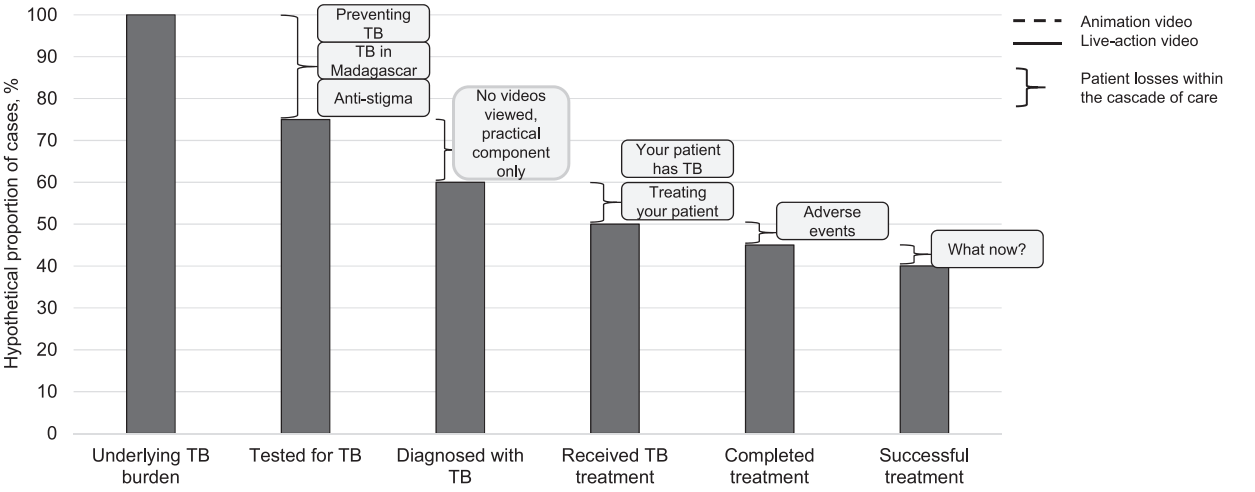

Figure 2 TB cascade of care with the implemented video training curriculum for community health workers. Cascade is based on hypothetical proportions. TB = tuberculosis.

study. The ITFL video used in this study is a modified version of the video used in the Mhalu et al. sputum sample study in Tanzania, with visuals customized to the southern Africa region.[21]

Individual videos were combined to form two distinct training curricula, addressing needs throughout the TB care cascade. The first video training curriculum was viewed by TB patients, presumptive TB cases, and community members (Figure 1). The second video training curriculum was viewed by CHWs (Figure 2) and consisted of slightly modified videos, which addressed disease management and care for TB patients. All videos were 2–5 min in length and delivered in the local language by the research team using portable tablets. Screenshots of the animated and live-action videos are presented in Figure 3.

Study design and analyses

A pre-test/post-test design was implemented to assess changes in knowledge of TB. All participants took the pre-test, a verbal, true/false questionnaire, to assess baseline knowledge. Participants were then shown the videos relevant to the visit. The post-test was administered immediately afterwards to measure knowledge change. Table 1 includes a sample of questions used in the tests. Each video was viewed only once. For each correct answer, one point was added to the total score. Total points varied, depending on which videos were viewed and number of questions administered for that video. As videos from each of the curricula were shown at different time points (Figures 1 and 2), questionnaires were specific to the video content covered in each particular visit.

Timing between viewing the videos and test administration was the same for all visits and all participants. Tests were conducted one-on-one and questions were read aloud to participants. Videos were viewed individually, except those during the initial sensitization visits, where groups of 5–10 participants watched the videos together. Only after the post-test were participants educated about the correct answers to the test questions.

Figure 3 Malagasy TB educational videos for patients, presumptive cases, communities, and community health workers. **A)** Scientific Animation Without Borders, "TB Prevention" animated video, available online at https://sawbo-animations.org. **B)** In Tune for Life, "Sputum Collection" animated video, available online at http://intuneforlife.org/sputum. **C)** Stony Brook University, "You have TB" live-action video. TB = tuberculosis.

Table 1 Select questions from the pre- and post-tests for the first and second video training curricula*

	Question	Answer	Corresponding video
Curriculum 1	While taking TB medication, your urine may turn orange or red in color; this is from the medication and indicates that you should stop taking your medication	False	• TB treatment • Adverse events
	Patients who correctly follow their treatment will not transmit TB to others and can therefore participate in activities in the community	True	• Anti-stigma
	TB can be transmitted from one person to another in the air, such as when someone who is sick coughs or sneezes	True	• What is TB • Preventing TB • TB prevention • Sputum collection • You have TB
Curriculum 2	Treating your patients' TB will prevent the spread of TB to others	True	• Your patient has TB • Treating your patient
	TB is an infectious disease that only ever affects the lungs and cannot affect other body parts	False	• TB in Madagascar • Your patient has TB
	If your patient is feeling better, it is ok for them to stop treatment	False	• Your patient has TB • Treating your patient

* Curriculum 1 was presented to TB patients, presumptive TB cases, and community members, while Curriculum 2 was presented to community health workers. TB = tuberculosis.

Changes in knowledge between the pre- and post-tests were calculated by subtracting the pre-test score (%) from the post-test score (%). Medians and interquartile ranges (IQRs) were compared and bivariate tests were conducted to compare test results. Test scores (%) on pre- and post-tests, as well as demographic variables and percentage change in scores were compared using paired, bivariate, and non-parametric tests. All analyses were stratified by participant groups and completed using RStudio, v1.1.453 (RStudio®, Boston, MA, USA).

Ethical considerations

This study obtained Institutional Review Board (IRB) approval from University of California, San Francisco, San Francisco, CA, USA (IRB #17-21517); Stony Brook University Committee on Research Involving Human Subjects, New York, NY, USA (#2017-4056-F); and the Ministry of Public Health of Madagascar (*Ministère de la Santé Publique/Comité d'Éthique de la Recherche Biomédicale*), Antananarivo, Madagascar (073-MSANP/CERBM). Written, informed consent was provided by all participants after detailed counselling in the local Malagasy dialect. TB patients and presumptive TB cases were given free medical care and treatment.

RESULTS

Study population characteristics

Between May and June 2018, 146 participants were recruited from 25 villages; 30.8% of participants reported no formal education, 55.5% were male and the median age was 39 years. Study population characteristics are shown in Table 2, including level of education and occupation. Participants were classified as follows: four (2.7%) TB patients, 20 (13.7%) presumptive TB cases, 115 (78.8%) community members, and seven (4.8%) CHWs.

Learning gains

Of the total 139 participants eligible to view the first video training curriculum (TB patients, presumptive TB cases, and community members), 85 (61.2%) improved their score on post-test, 45 (32.4%) obtained the same score, and 9 (6.5%) received a worse score. Of the 45 participants who achieved the same score, 26 (18.7%) obtained 100% on both tests and therefore had no ability to improve their score. Among the seven CHWs who viewed the second video training curriculum, one (14.3%) improved their score, one (14.3%) obtained a worse score, and the remaining five (71.4%) achieved the same score (two of whom received 100.0% on both tests).

The median overall percentage change between pre- and post-tests for all participants was 10.0% (IQR 0.0–20.0). The median pre-test score was 87.5% (IQR 70.4–90.0) and the median post-test score was 100.0% (IQR 88.9–100.0) (Table 3). Bivariate comparisons of the percentage scores revealed a statistically significant difference between pre- and post-test scores ($P < 0.001$). Similarly, there was a statistically significant difference between the number of correct answers on pre-test and the number of correct answers on post-test ($P < 0.001$).

Bivariate tests revealed no statistically significant difference in categorical percentage change (improved vs. not improved) across demographic characteristics. While there was no significant difference in categorical score change by gender, the majority of the women (72.3%) improved their score on post-test; 70.0% of those who did not improve their score were male participants. Continuous percentage change in score between pre- and post-tests did not show a statistically significant association by participant age. Each of the demographic characteristics and variables, except gender and the number of videos viewed by the participant, indicated a statis-

Table 2 Univariate descriptive statistics of the study population stratified by participant group

Variable	TB patients *n* (%)	Presumptive cases *n* (%)	Community members *n* (%)	Community health workers *n* (%)	Total *n* (%)
n	4	20	115	7	146
Age, years, median [IQR]	32 [24–34]	41 [28–49]	38 [25–51]	42 [33–53]	39 [25–51]
Age group, years					
15–29	1 (0.7)	6 (4.1)	39 (26.7)	2 (1.4)	49 (33.6)
30–44	2 (1.4)	7 (4.8)	25 (17.1)	2 (1.4)	35 (24.0)
45–59	1 (0.7)	5 (3.4)	34 (23.3)	3 (2.1)	43 (29.5)
≥60	0	2 (1.4)	13 (8.9)	0	15 (10.3)
Unknown	0	0	4 (2.7)	0	4 (2.7)
Sex					
Male	3 (2.1)	9 (6.2)	62 (42.5)	7 (4.8)	81 (55.5)
Female	1 (0.7)	11 (7.5)	53 (36.3)	0	65 (44.5)
Marital status					
Married	2 (1.4)	11 (7.5)	96 (65.8)	5 (3.4)	114 (78.1)
Single	1 (0.7)	6 (4.1)	9 (6.2)	2 (1.4)	18 (12.3)
Separated/widow/divorced	1 (0.7)	2 (1.4)	10 (6.8)	0	13 (8.9)
Unknown	0	1 (0.7)	0	0	1 (0.7)
Level of education					
None	1 (0.7)	12 (8.2)	32 (21.9)	0	45 (30.8)
Primary	3 (2.1)	7 (4.8)	67 (45.9)	3 (2.1)	80 (54.8)
Secondary	0	1 (0.7)	16 (11.0)	4 (2.7)	21 (14.4)
University/college	0	0	0	0	0
Occupation					
Farmer	3 (2.1)	20 (13.7)	112 (76.7)	0	135 (92.5)
Healthcare & farmer	1 (0.7)	0	0	6 (4.1)	7 (4.8)
Teacher	0	0	2 (1.4)	0	2 (1.4)
Healthcare	0	0	0	1 (0.7)	1 (0.7)
Other	0	0	1 (0.7)	0	1 (0.7)
Number of videos viewed					
One	0	0	37 (25.3)	2 (1.4)	39 (26.7)
Two	1 (0.7)	20 (13.7)	0	1 (0.7)	22 (15.1)
Three	3 (2.1)	0	78 (53.4)	4 (2.7)	85 (58.2)

TB = tuberculosis; IQR = interquartile range.

tically significant difference between at least two of the sub-groups. Sub-group analyses revealed the percentage change in score of those who reported their occupation as solely a farmer was significantly greater than those who reported working as a CHW and farmer ($P = 0.009$). Finally, there was a statistically significant difference in percentage change in scores between community members and CHWs ($P = 0.010$), as well as CHWs and presumptive TB cases ($P = 0.008$). Community members and

Table 3 Pre- and post-test scores, percentage change, and associated *P* values by participant group, exposure, highest level of education, and type of video

	n	Pre-test Median % [IQR]	Post-test Median % [IQR]	% Change Median [IQR]	*P* value
All	146	87.5 [70.4–90.0]	100.0 [88.9–100.0]	10.0 [0.0–20.0]	<0.001
Participant group					
TB patients	4	92.0 [86.9–94.0]	96.0 [90.4–100.0]	4.0 [0.0–9.6]	0.371
Presumptive cases	20	75.0 [67.2–87.5]	93.8 [87.5–93.8]	15.6 [6.3–25.0]	<0.001
Community members	115	88.9 [77.8–90.0]	100.0 [90.0–100.0]	10.0 [0.0–20.0]	<0.001
CHWs	7	92.9 [79.3–96.4]	92.9 [69.3–100.0]	0.0 [0.0–0.0]	1
Exposure*					
1 video	37	77.8 [66.7–88.9]	88.9 [88.9–100.0]	11.1 [0.0–11.1]	<0.001
2 videos	21	75.0 [68.8–87.5]	93.8 [87.5–100.0]	13.4 [6.3–25.0]	<0.001
3 videos	81	90.0 [80.0–100.0]	100.0 [90.0–100.0]	8.0 [0.0–20.0]	<0.001
Level of education*					
None	45	80.6 [69.7–90.0]	93.8 [88.9–100.0]	10.6 [0.0–20.6]	<0.001
Primary	77	88.2 [71.1–92.5]	100.0 [90.0–100.0]	10.0 [0.0–20.0]	<0.001
Secondary	17	88.9 [80.0–90.0]	100.0 [88.9–100.0]	10.0 [0.0–20.0]	0.002
Type of video*					
Animation	57	77.8 [68.8–88.9]	92.0 [87.5–100.0]	11.1 [0.0–22.2]	<0.001
Live action	82	90.0 [80.0–100.0]	100.0 [90.0–100.0]	10.0 [0.0–20.0]	<0.001

* Does not include CHWs as they viewed the second video training curriculum.
IQR = interquartile range; TB = tuberculosis; CHW = community health worker.

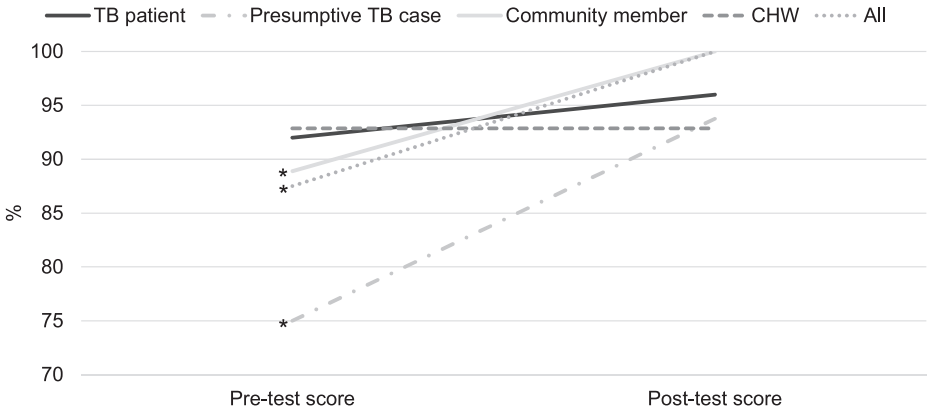

Figure 4 Comparison of overall median pre-test score (%) and post-test score (%) stratified by participant group. *$P < 0.05$. TB = tuberculosis; CHW = community health worker.

presumptive TB cases both had a greater percentage change in score than CHWs (Figure 4).

DISCUSSION

Our findings suggest that educational videos can serve as an effective tool for TB education among low-literacy, geographically remote populations. While numerous studies have evaluated educational videos for other clinical conditions, few have assessed effectiveness of educational videos in improving understanding of TB. In Canada, Gao et al. found that a video on latent TB infection (LTBI) was effective in improving knowledge among LTBI clinic patients.[22] In El Salvador and the Solomon Islands, video-based education was successful in improving participants' understanding of TB.[23,24] In The Gambia, Martin et al. found that using local participants to produce an educational video on TB led to empowerment through acquisition of knowledge.[25] Finally, Mhalu et al. found that the ITFL sputum production educational video for patients in Tanzania was effective in improving quality of sputum samples collected from presumptive TB patients.[21] Our results are thus consistent with the findings of other TB video education studies in high- and low-resource settings.

While the videos improved knowledge overall, different participant groups benefited disproportionately. Presumptive TB cases and community members both significantly improved their median scores between pre- and post-tests. While those presumed to have TB may have had a vested interest in learning more about the disease, community members may represent a more neutral audience. The significant improvement in test scores among this general audience suggests that learning gains can be achieved even among populations that do not necessarily have a personal stake in learning about TB. Furthermore, given the airborne nature of the disease, it is important that the videos successfully improved TB knowledge among the general community. While TB patients improved their scores overall, the lack of statistical significance may be explained by small sample size and high initial pre-test scores. TB patients received counselling on their diagnosis in previous medical visits, which may explain high pre-test scores. Unlike other participant groups, CHWs on average, did not improve their score between tests. CHWs high initial scores on pre-test indicate that their baseline level of TB knowledge was higher than other groups; this could be attributed to prior training or experience with TB.

The study contributes to the overall literature on health education videos by assessing their effectiveness in improving knowledge of TB across the care cascade among remote, low-literacy populations. This study illustrates that limited prior experience with technology is not a barrier to learning new information. Several participants noted after viewing the live-action videos that they enjoyed seeing people they recognized to be the medical team. Although we did not analyze the difference between the animated and live-action films, our observations in the field suggest that the live-action videos may have been more appealing to participants.

Limitations

We did not assess what specific knowledge was gained by participants, nor which videos they gained knowledge from. It is possible that participants only gained knowledge in one area of TB care, such as prevention or treatment, and that they only learned from one of the videos they viewed. Additional studies are required to assess the impact of specific information gained and retained from each video.

A further limitation of our study is generalizability of the results to TB patients and CHWs, as the majority of participants were community members (78.8%). Videos may be most effective for educating populations who have a current interest in learning about the disease; however, our study did not explore

this hypothesis. This study is also limited by absence of long-term follow-up to assess knowledge retention, as the post-test was administered immediately after viewing the video training curriculum.

CONCLUSIONS

Our study shows that educational videos can be used as a tool for improving TB knowledge among remote populations in Madagascar. Given significant barriers to educating these isolated, low-literacy populations, it is promising that this educational approach was effective in improving general knowledge of TB prevention, diagnosis and treatment. The rapid increase in the use of mobile devices in high TB burden countries provides a massive and scalable opportunity for using video education in similar settings.[8] TB control programs should leverage technological devices and open-access educational material to deliver key information about TB to patients and providers. We envision a future in which a global panel of validated videos are freely available online and can be delivered on demand to patients and providers when they are most amenable to learning.

The results of this study support further research into the use of TB educational videos in other settings. Videos may be beneficial in more resource-rich settings where they could be widely disseminated and accessed by the general population. By distributing videos more broadly, knowledge of TB prevention could become more widespread, leading to an overall decrease in disease incidence. Future studies should explore if videos affect treatment adherence, disease outcomes, and time to seeking care or diagnosis. Further research is needed to draw conclusions about the effectiveness of videos among TB patients and CHWs specifically and to explore whether live-action or animated videos are more conducive to learning among urban and rural communities. Furthermore, NTPs should implement currently available educational videos, assess their impact locally, and tailor content and format to country-specific needs. All of these potential studies could have substantial implications for TB control globally. Utilizing innovative approaches may be key to improving TB care and control.

Acknowledgements

The authors wish to thank the villages in the Androrangavola commune and members of the DrOTS field research team, M F R Raelison, R M Rabetombosoa, I V Ambinintsoa, O Nimbol, S Henintsoa, Z G Sendranirina, R Ramaminiaina, and M A Soloherindray.

This project was supported by the Stop TB Partnership's TB REACH initiative, and was funded by the the Government of Canada (Ottawa, ON, Canada) and the Bill & Melinda Gates Foundation (Seattle, WA, USA).

Conflicts of interest: none declared.

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RÉSUMÉ

CONTEXTE : L'accès à l'information relative à la tuberculose (TB) est vital pour promouvoir un diagnostic et un traitement précoces ainsi qu'une lutte au sein des communautés vulnérables. De meilleures approches de la distribution du matériel d'éducation pour la santé dans les populations isolées sont requises.

OBJECTIF : Evaluer l'impact de deux programmes complets de formation vidéo sur l'amélioration des connaissances en matière de TB, des patients, des membres de la communauté et des travailleurs de santé communautaire dans des zones isolées de Madagascar.

SCHÉMA : Un schéma pré-test/post-test a été utilisé pour mesurer l'acquisition des connaissances. Les vidéos éducatives étaient courtes, culturellement appropriées et présentées à des moments cruciaux de la cascade de soins de la TB.

RÉSULTATS : Sur un total de 146 participants, 86 (58,9%) ont amélioré leur score lors du post-test, 50 (34,2%) ont obtenu le même score et 10 (6,8%) ont eu un score plus mauvais. Une différence statistiquement significative a été observée dans les scores du pré- et post-test, l'augmentation médiane étant de 10,0% (intervalle interquartile 0,0–20,0) après avoir vu les vidéos ($P < 0,001$). Il y a eu une différence significative entre le nombre de réponses correctes au pré-test et le nombre de réponses correctes au post-test ($P < 0,001$).

CONCLUSION : Les vidéos éducatives ont abouti à une amélioration significative des connaissances en matière de TB au sein d'une population peu alphabétisée et isolée de Madagascar. Nos résultats suggèrent que des vidéos éducatives pourraient constituer un outil peu coûteux et pérenne d'amélioration de l'accès au matériel d'éducation à la TB dans le monde.

RESUMEN

MARCO DE REFERENCIA: El acceso a la información sobre la tuberculosis (TB) es fundamental en la promoción del diagnóstico y el tratamiento oportunos y el control de la enfermedad en las comunidades vulnerables. Es necesario contar con mejores métodos de difusión de los materiales de educación en salud dirigidos a las poblaciones que residen en zonas distantes.

OBJETIVO: Evaluar el impacto de dos videos con programas educativos exhaustivos, destinados a mejorar los conocimientos en materia de TB de los pacientes, los miembros de la comunidad y la comunidad de profesionales de salud en una región distante de Madagascar.

MÉTODO: Se utilizó el método de evaluación antes y después de la intervención con el fin de medir la adquisición de conocimientos. Los videos educativos eran cortos, adaptados culturalmente y se presentaban en puntos fundamentales de la secuencia asistencial de la tuberculosis.

RESULTADOS: De los 146 participantes, 86 (58,9%) mejoraron su puntuación en la prueba posterior a la intervención, en 50 (34,2%) la puntuación fue estable y en 10 participantes (6,8%) el resultado final fue inferior al primer resultado. Se observó una diferencia estadísticamente significativa entre las puntuaciones iniciales y finales, con una mediana del aumento de 10,0% (amplitud intercuartil 0,0-20,0) después de haber visto los videos ($P < 0,001$). Hubo una diferencia significativa entre el número de respuestas correctas en la primera prueba y el número de respuestas correctas en la prueba posterior a la intervención ($P < 0,001$).

CONCLUSIÓN: Los videos educativos mejoraron de manera notable los conocimientos sobre la TB en una población con tasas de alfabetización bajas en una región distante de Madagascar. Estos resultados indican que los videos educativos son una herramienta potente, de bajo costo y sostenible para mejorar el acceso a materiales pedagógicos sobre la TB en todo el mundo.