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From song to stories: assessing the impact of exposure to arts-based community engagement tools in shaping knowledge, attitudes, and acceptability toward the Sterile Insect Technique for malaria control in South Africa

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Abstract

Background Community engagement (CE) is essential for public health interventions. This is particularly important when introducing novel technologies, such as the Sterile Insect Technique (SIT), that require strong community understanding and acceptance. Against this background, arts-based CE strategies, including music, drama, and radio short stories, were developed and piloted, but their effectiveness remained unevaluated. This study assessed whether exposure to arts-based CE approaches influenced community knowledge, attitudes, and acceptance of the SIT in uMkhanyakude District, KwaZulu-Natal, South Africa.

Methods A cross-sectional survey to understand the influence of arts-based CE approaches was conducted in the Jozini municipality, uMkhanyakude District, after community exposure to these CE productions. Structured interviews were conducted with randomly sampled community members. Data were collected on CE exposure and SIT-related knowledge, attitudes, and acceptance. A chi-square test and a stepwise ordinal logistic regression were used to analyse the data after adjusting for sociodemographic factors.

Results Among 614 participants, only 26.2% (n = 161) were exposed to arts-based CE approaches. Those exposed were more likely to correctly identify that female mosquitoes feed on blood as compared to the unexposed (95.0% vs. 85.8%, p = 0.008), and to express support for SIT (e.g., 98.1% vs. 89.4% agreed with upcoming releases, p = 0.003). Exposure remained a significant predictor of SIT acceptance in multivariate models (OR 0.65, 95% CI 0.45–0.94). Positive attitudes and accurate knowledge also independently predicted greater acceptance.

Conclusion Arts-based CE tools were effective in supporting the introduction of SIT by improving knowledge and acceptance. However, limited exposure suggests the need for more sustained and widely accessible engagement strategies to maximize reach and long-term impact. These findings suggest that artistic productions, especially

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when delivered through culturally relevant, multimodal formats, play a meaningful role in shaping community receptiveness to novel vector control methods like the SIT.

Keywords Malaria control, Sterile Insect Technique, Community engagement, Arts-based approaches, Knowledge, Attitudes, And acceptability

Background

The World Health Organization (WHO) Global Technical Strategy (GTS) for Malaria 2016–2030 provides a roadmap to reduce global malaria incidence and mortality rates by 90% for malaria-endemic countries [1]. The main vector control approach in South Africa (SA) is IRS supplemented by winter larviciding [2]. This approach, in part, has reduced the country's malaria burden [3]. However, although significant progress has been made, the current malaria vector control strategies are unlikely to achieve malaria elimination without supplementation [2]. Against this background, alternative vector control strategies to complement the existing approach are under investigation.

South Africa is exploring the feasibility of the Sterile Insect Technique (SIT), an innovative vector control method [4–6]. SIT is an environmentally friendly vector management strategy that involves releasing sterile male mosquitoes into wild target populations. The released sterile males compete with native males to mate with wild females. If the wild females mate with the released sterile males, their offspring are not viable. Thus, consistent and regular releases will reduce the mosquito vector population density, thereby reducing the rate of transmission and the burden of malaria [7]. As SIT involves the release of mosquitoes, its success depends heavily on community understanding of the technology, and on their acceptance and cooperation [8]. Therefore, community education and engagement activities are needed for communities to understand the principles of the SIT and to support its implementation.

Community engagement (CE) has been recognized as pivotal in addressing the challenges of trust, awareness, and participation. The WHO emphasizes CE as central to public health interventions and defines CE as a collaboration process with all relevant stakeholders to achieve shared goals while respecting community beliefs and contributions [9]. There are several approaches available for engaging communities to raise health awareness, address stigma, and promote behaviour [8, 10–12]. Of these, arts-based approaches have emerged as innovative and culturally resonant tools.

Studies have demonstrated the effectiveness of arts-based strategies, such as music, drama, and storytelling, as engagement tools [12–15]. For instance, engagement using music in Gambia successfully motivated community members to repair their bed nets, which was the desired behaviour change [15]. In South Africa's KwaZulu-Natal province, the use of music to foster HIV/AIDS awareness and prevention within isiZulu-speaking communities resulted in reduced stigma, improved openness around HIV status, and the strengthening of community dialogue and emotional support networks [16, 17]. Similarly, storytelling and drama, delivered through mass media or live performances, proved effective in sensitizing communities on health issues, particularly during HIV/AIDS campaigns across Africa [12]. In addition, Birdthistle and colleagues [18] reported increased interest in HIV testing and uptake of Prep due to exposure to the Shuga multimedia campaign. In a study in South Africa, exposure to school-based dramas and public theatre performances resulted in improved knowledge and attitudes toward HIV/AIDS, often leading to increased uptake of voluntary counselling and testing services [19]. These results demonstrate the potential effectiveness of arts-based CE strategies. Despite this, there is limited application of such strategies for malaria control.

While research has highlighted the importance of CE in malaria control, there is a gap in the literature on the use of art-based CE approaches, particularly within a South African context. Most malaria-related CE efforts in SA have traditionally focused on health education campaigns and community mobilization. These interventions have often relied on radio broadcasts, pamphlets, and community meetings rather than creative, arts-based approaches. Arts-based approaches, such as music, drama, and storytelling, offer effective communication strategies that resonate with local cultural norms by utilising community preferences for understanding complex issues [20, 21]. This is crucial in enhancing community understanding and acceptance of new malaria intervention technologies like the SIT, which requires substantial community buy-in and cooperation for successful implementation.

In response to this need, the South African SIT project developed a range of locally relevant CE strategies using participatory, arts-based formats. With input from community members, educators, and local leaders, the project co-created tools such as songs, radio short stories, and school-based drama to communicate the science and purpose of SIT in accessible ways. These formats

were deliberately selected based on community preferences and local media consumption patterns and were integrated into outreach activities and public events. While these tools were reported to be engaging and well-received, their actual impact on public knowledge, attitudes, and acceptance was not systematically evaluated. This study, therefore, assessed whether exposure to arts-based CE strategies was associated with differences in community knowledge, attitudes, and acceptance of the SIT in KwaZulu-Natal. Additionally, the study explored the broader role and contribution of the arts in public health during the implementation of the SIT.

Methods

Study design and setting

This was a cross-sectional study conducted in the Jozini Local Municipality, uMkhanyakude district, KwaZulu-Natal, SA. Jozini was earmarked and targeted for a pilot SIT release programme because of the presence of a perennial and isolated population of *Anopheles arabiensis*. The SIT works best where transmission is being driven by one vector species that is isolated with very limited immigration of other vector species [22]. In addition, the Jozini municipality is targeted for malaria elimination due to persistently low (< 1 case per 1 000) malaria incidence [23]. There are 44,584 households in Jozini, with 65% of the population under 25 years-of-age. Children 0–14 years and those 15–24 years make up 41.5% and 23% of the population, respectively. Only 3.4% of the total population is over 65 years-of-age. Three healthcare facilities serve the Mamfene community of the Jozini municipality. It also features a community hall, two churches, 21 secondary schools, five primary schools, four colleges, and a community radio station [24].

Arts development

The research team enlisted the support of key stakeholders, including community leaders (known as section heads), SIT field assistants, local radio station managers, and teams from the local malaria control programme to collaboratively conceptualize arts-based engagement tools—specifically music, radio short stories, and drama. This process occurred during scheduled general community engagement meetings. Community members and their leaders identified their preferred creative approaches. A pamphlet was designed for use in the development of each artistic piece and provided relevant information and guidance during the development of each piece, including extensive consultation with the creative teams. To support the development of these artistic initiatives, an SIT pamphlet (Additional File 1) was provided as a guide for each creative form, as outlined below:

Music

A local "Maskandi" artist was enlisted to compose and record a song. The lyrics were mainly based on information in the pamphlet. The completed song was first introduced into the community during a malaria commemoration event in 2021.

Short stories

Radio short stories, known as "umdlalo womoya," were created by a drama team based at the Maputaland community radio station with consultation from the first author and the SIT field team members. The station serves a population of approximately 555,000 people, with 165,000 regular listeners (Broadcasting Research Council, 2021). Once finalized, these stories were aired during the station's prime afternoon slot at 3:20 PM. Of the 10 stories developed, six focused on themes related to SIT knowledge, attitudes, and acceptability, while the remaining four addressed malaria-related topics.

Drama

Life Orientation educators from four local schools, along with their students, contributed to the development of a malaria and SIT-focused drama under the guidance of the first author and SIT field teams who ensured that the context of the drama remained relevant to the SIT theme. The schools were organized into junior (Grades 5 and 6) and senior (Grades 9 and 10) divisions, with four classes per grade and around 70 students per class. Four drama teams performed the play during a World Malaria Day commemoration event of 2022.

Sample size

The sample size was calculated using the single population proportion formula based on previous research findings [25]. It was assumed that exposure to arts-based CE would increase SIT-specific knowledge, attitudes, and acceptance by 50% (p = 0.5). A 95% confidence level was used (Z = 1.96), with a relative precision of 5% (d = 0.05), a design effect of 1.5, and a 10% non-response rate. This is detailed below, where n = sample size, Z = score of 95% confidence level, P = estimated prevalence of knowledge, attitudes, and acceptability level, and d = relative precision. Substituting these values:

$$n = \frac{z^2 \mathrm{p}(1-P)}{D^2} \text{ whereby } n = \frac{1.96^2\, 0.5(1-0.5)}{0.05^2} = 384.16 \approx 385$$

A design effect of 1.5 was applied, giving $385 \times 1.5 = 577.5 \approx 578$, and allowing for a 10% non-response rate, the required sample size was: $578 + (578 \times 0.10) = 635.8 \approx 636$. For operational feasibility, the sample

size was rounded to the target of 600 participants. Additionally, 29 pilot survey participants were included in the final dataset, resulting in a sample size of 629.

Study population and sampling

The study population only included adults aged 18 years and above who had resided in the Mamfene Sects. 2, 8, and 9 for more than five years. This decision was guided by ethical considerations, as persons under 18 are legally regarded as minors in SA and cannot provide independent consent to participate in research. In addition, the study focused on knowledge, attitudes, and acceptance of SIT, which are domains most relevant to adults who are legally recognized decision-makers and directly engaged in community health and malaria control interventions. Individuals who refused to give consent and those under 18 were excluded.

A two-stage random sampling approach was used to select participants. In the first stage, households were randomly selected from a list of households provided by the malaria control programme in KZN, applying a random number generation in Excel. In the second stage, one eligible individual per household was randomly selected using a balloting method. When an eligible individual was identified but not at home, one additional attempt was made, after which the sampled individual was excluded if they were not available or willing to participate, without replacement. The final sample size of 629 exceeded the initial estimated 600, accounting for potential non-response while ensuring sufficient statistical power.

Questionnaire development

The community questionnaire was divided into five sections: demographic characteristics, SIT knowledge, SIT attitudes, SIT acceptability, and community engagement questions. The questionnaire was adapted from a tool previously used during a community knowledge, attitudes, and practices survey on malaria and SIT in KwaZulu-Natal [25]. Several modifications were made to tailor the instrument to the current study objectives and the specific focus on arts-based CE and the SIT. These modifications included adding new questions on knowledge, attitude, practices, and exposure to arts-based approaches (music, drama, and radio), and removing items that were not directly relevant to the SIT. The questionnaire was translated into isiZulu, the local language spoken in the study area, by an expert who is fluent in both English and isiZulu.

To ensure content validity and contextual relevance, malaria researchers and the first author, who is fluent in both isiZulu and English, reviewed the revised questionnaire (Additional file 2). The tool was then pilot tested with community members from a comparable setting. Feedback from the pilot was used to refine question wording, response options, and flow. This process confirmed the questionnaire's comprehensibility, cultural appropriateness, and reliability for use in the main survey. Pilot data were included in the final analysis.

Data collection

The structured questionnaire was administered door-to-door in RedCap (Research Electronic Data Capture) tools hosted at the University of the Witwatersrand [26]. A secure, web-based software platform designed to support data capture for research studies by the field workers and the first author. Before questionnaire administration, the study objectives and procedures were clearly explained and discussed with all participants to obtain informed consent. Written consent was obtained from the participants through signing a consent form. Data collection was done over a period of three months from October to December 2022. A total of 629 forms was captured, including 29 from the pilot study.

Data management and analysis

Survey data were captured in RedCap and exported to STATA. Before analysis, the potential for creating SIT knowledge, attitudes, and acceptability scales was explored. However, given low reliability scores, a decision was made to present individual items. There were eight knowledge questions, six attitude questions, and five acceptance questions included in the survey. Several questions intentionally included incorrect information to assess the depth and accuracy of understanding (e.g., whether participants could correctly identify misinformation about mosquito biology and the SIT process). Exposure to arts-based CE strategies, the key independent variable, was measured as a binary variable, indicating whether participants reported interaction with at least one arts-based CE tool (exposed "Yes") or none (not exposed "No"). In addition, descriptive analyses explored variation in exposure intensity (i.e., number of art forms encountered). The main outcomes were individual items related to knowledge, attitudes, and acceptability of the SIT. These were treated as ordinal categorical variables and analysed independently to assess their association with CE exposure.

Statistical analysis was conducted using STATA Version 15. Descriptive analysis was used to summarize participants' demographic information and exposure levels. Chi-square tests (or Fisher's exact test where appropriate) were used to explore bivariate associations between exposure and individual knowledge, attitude, and acceptance items. For multivariate analysis, a stepwise ordinal logistic regression was conducted to identify factors

associated with greater acceptance of the SIT. Three models were developed: 1) Model 1 included exposure and demographic variables (age and education), 2) Model 2 added four knowledge items that were statistically significant in the bivariate analysis, and 3) Model 3 retained one significant knowledge item and one attitude variable to assess their combined effects on SIT acceptance. Odds ratios (ORs) with 95% confidence interval (CI) were reported, and a significance level of $p < 0.05$ was used. All models were adjusted for potential confounders.

Results

A total of 629 questionnaires was administered, with no refusals. Only 1.9% (n = 15) of the forms were excluded from analysis because information on age was missing.

Characteristics of study participants

Participants' ages ranged from 18 to 85 years, with a median age of 40 (IQR: 32–55). The majority were female, accounting for 60.9% (n = 373) of the sample. Most participants (66.3%, n = 405) had completed secondary education, and an equal proportion (66.2%, n = 405) were unemployed. Over 80% (n = 540) of households had access to multiple communication sources, including a radio, television, and cell phone. Additionally, 94.3% (n = 576) reported having school-going children in their households. A total of 34.1% (n = 194) indicated that at least one household member had been diagnosed with malaria at some point (Table 1).

Table 1 Demographic characteristics and malaria history of participants during a survey in KwaZulu-Natal Province, South Africa

*Characteristics	N = 614	Percentage
Age		
Median age (IQR)	40 (32–55)	
Age categories		
18–35	248	40.4
36–50	182	29.6
51 +	184	30.0
*Gender		
Male	239	39.1
Female	373	60.9
*Level of education attained		
No schooling	84	13.7
Primary level	122	20.0
Secondary and above	405	66.3
*Employment status		
Student	49	8.0
Unemployed	405	66.2
Employed	77	12.6
Pensioner	81	13.2
Items owned in households		
Radio	544	88.6
Television	541	88.1
Mobile phone	601	97.8
Electricity	597	97.2
Car	126	20.5
Tractor	21	3.4
Bicycle	57	9.2
*School going children		
Yes	576	94.3
No	35	5.7
*Family history of malaria		
Yes	194	34.1
No	375	64.9

* missing responses are not included

Exposure to arts-based CE approaches on the SIT

Out of 614 participants, 30.6% (n = 188) reported exposure to information on the SIT. Among the 188 exposed participants, approximately 14.7% (n = 90) had a high level of exposure, engaging with two or more methods of exposure. A total of 4.4% (n = 27) participated in events, and campaigns. Only 26.2% (n = 161) were exposed to arts-based community engagement approaches. A total of 24.4% (n = 150) were exposed to SIT through songs, 4.1% (n = 25) were exposed via short stories, and 15.3% (n = 94) encountered drama performances (Fig. 1).

Associations between exposure to arts-based approaches and SIT knowledge, attitude, and acceptability

In bivariate analysis, significant associations were observed for four of the eight knowledge items. Participants who were exposed to at least one art form were more likely to correctly identify that *"female mosquitoes feed on blood"* compared to their unexposed counterparts (95.0% vs. 85.8%, $p = 0.008$) and were also less likely to believe the incorrect statement that *"female mosquitoes do not bite"* ($p = 0.016$). Exposure to at least one art form was also associated with lower misconceptions, including those who believed that *"SIT targets mosquitoes that feed and rest indoors only"* ($p = 0.027$) and that *SIT will replace indoor residual spraying* ($p = 0.030$).

In terms of attitudes, a significantly higher proportion of participants exposed to an art form strongly agreed that *"SIT is a good method because it acts as an additional malaria control tool"* ($p = 0.022$). For acceptability, the statement *"I am looking forward to the release of sterilized male mosquitoes in my area"* had significantly more agreement among participants exposed to at least one art form (98.1% vs. 89.4%, $p = 0.003$), suggesting greater acceptance of the intervention (Table 2).

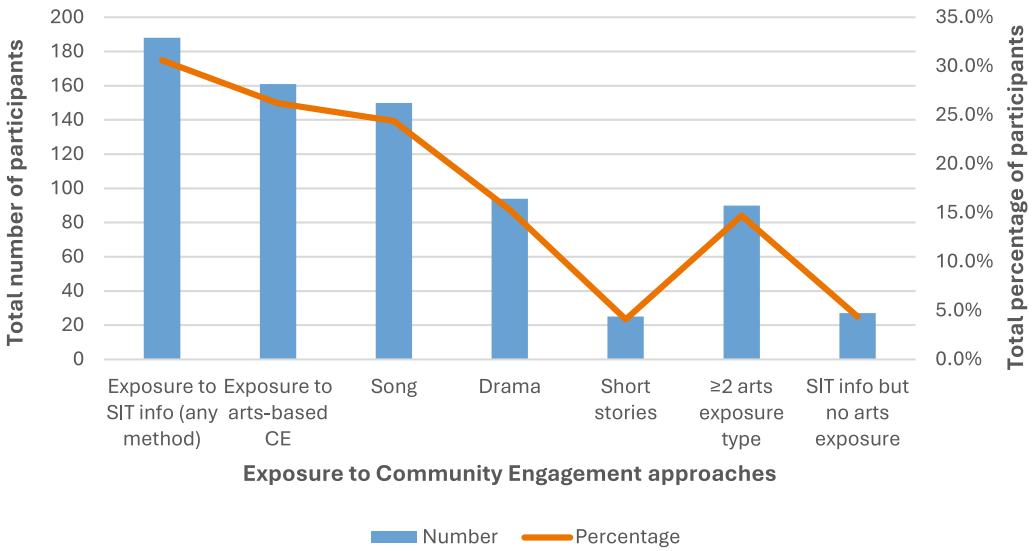


Fig. 1 Exposure to different arts-based strategies used to engage the community on the Sterile Insect Technique in the KwaZulu-Natal province, South Africa

Factors associated with acceptance of SIT

To identify factors associated with community acceptance of the SIT, a multivariable regression analyses was conducted, examining the influence of demographic characteristics and exposure to arts-based CE tools. Model 1 showed that exposure to arts-based CE tools was significantly associated with higher acceptance of SIT (OR 0.64, 95% CI 0.44–0.99, $p=0.020$). Participants with secondary education or above showed a trend suggesting higher acceptance compared to those with no schooling; however, this was not statistically significant (OR 1.60, 95% CI 0.97–2.64, $p=0.064$) (Table 3).

After adding four knowledge items that were statistically significant in the bivariate analysis (Model 2), data showed that the association between exposure and SIT acceptance remained significant (OR 0.66, 95% CI 0.46–0.97, $p=0.036$). Notably, correct knowledge that "*female mosquitoes feed on blood*" was significantly associated with SIT acceptance (OR 0.45, 95% CI 0.22–0.92, $p=0.030$). Furthermore, after retaining the only significant knowledge item "*female mosquitoes feed on blood* " and adding a key attitude variable "*SIT is a good method because it acts as an additional malaria control tool* " (Model 3) both remained significantly associated with acceptance: knowledge (OR 0.47, 95% CI 0.23–0.94, $p=0.034$) and attitude (OR 0.69, 95% CI 0.48–0.97, $p=0.034$). Exposure to art forms continued to show a positive effect on the acceptance of SIT, with exposed participants more likely to agree with statements supporting the release of sterile male mosquitoes in their community (OR 0.65, 95% CI 0.45–0.94, $p=0.026$) (Table 3).

Discussion

South Africa is exploring the feasibility of the use of SIT, an innovative vector control method. As part of this process, art-based CE strategies were developed and piloted to increase uptake of the technology. Before these strategies can be rolled out, their appropriateness and effectiveness must be assessed. This study evaluated whether exposure to arts-based CE approaches, including Maskandi music, radio short stories, and school drama, were associated with community knowledge, attitudes, and acceptance of the SIT for malaria control in KwaZulu-Natal. The study showed that exposure to at least one of the arts-based CE tools was significantly associated with improved understanding of SIT, more positive attitudes toward the intervention, and greater acceptance of its implementation. Accurate understanding of key concepts, such as mosquito biology, was a strong predictor of SIT acceptability. While exposure was limited overall, the CE formats resonated strongly with those who accessed them. These findings suggest that arts-based community engagement can make a meaningful contribution to public understanding and support for novel vector control technologies. The following sections discuss these findings in relation to sampling, demographics, exposure patterns, knowledge outcomes, attitudes, and the role of these factors in influencing SIT acceptance.

The sampling strategy was designed to reflect geographic diversity among participants, with proportional representation from areas where SIT-related activities had taken place. The final sample included a mix of age groups, both genders, and a range of educational backgrounds, largely consistent with the general demographic

Table 2 Association between exposure to arts-based community engagement approaches and participants' knowledge, attitudes, and acceptability of SIT in KwaZulu-Natal, South Africa

Knowledge items (anticipated/correct response)	Response option	Actual response by exposure category (% of respondents/option)		p-value
		not exposed	exposed	
The SIT involves releasing laboratory-reared mosquitoes (TRUE)	TRUE	444 (98.23)	158 (98.75)	0.905
	FALSE	4 (0.88)	1 (0.88)	
	Don't know	4 (0.88)	1 (0.63)	
Female mosquitoes are sterilized and released (FALSE)	TRUE	47 (10.40)	9 (5.63)	0.106
	FALSE	379 (83.85)	145 (90.63)	
	Don't know	26 (5.75)	6 (3.75)	
Female mosquitoes do not bite (FALSE)	TRUE	90 (19,96)	16 (10.00)	0.016
	FALSE	336 (74.50)	135 (84.38)	
	Don't know	25 (5.54)	9 (5.630	
Female mosquitoes feed on blood (TRUE)	TRUE	388 (85.84)	152 (95.00)	0.008
	FALSE	36 (7.96)	5 (3.13)	
	Don't know	28 (6.19)	3 (1.88)	
SIT is a birth control method that uses sterile male mosquitoes (TRUE)	TRUE	320 (70.80)	121 (75.63)	0.137
	FALSE	98 (21.68)	34 (21.25)	
	Don't know	34 (7.52)	5 (3.13)	
SIT targets mosquitoes that feed and rest indoors only (FALSE)	TRUE	85 (18.81)	20 (12.50)	0.027
	FALSE	251 (55.53)	108 (67.50)	
	Don't know	116 (25.66)	32 (20.00)	
SIT will replace the indoor residual spraying (FALSE)	TRUE	106 (23.45)	23 (14.37)	0.030
	FALSE	237 (52.43)	87 (54.37)	
	Don't know	109 (24.12)	50 (31.25)	
Both males and females will be released into the community (FALSE)	TRUE	60 (13.27)	13 (8.13)	0.196
	FALSE	326 (72.12)	125 (78.13)	
	Don't know	66 (14.60)	22 (13.75)	
Attitude items				
Malaria is a health problem in your community that needs to be addressed (Positive)	Strongly agree	98 (21.68)	33 (20.63)	0.795
	Agree	332 (73.45)	121 (75.63)	
	Disagree	22 (4.87)	6 (3.75)	
SIT will help with malaria control in the community (Positive)	Strongly agree	251 (55.53)	97 (60.62)	0.189
	Agree	151 (33.41)	53 (33.13)	
	Disagree	50 (11.6)	10 (6.25)	
Releasing sterilized mosquitoes in our community is a bad idea (Negative)	Strongly agree	68 (15.04)	20 (12.58)	0.078
	Agree	192 (42.48)	84 (53.82)	
	Disagree	192 (42.48)	55 (34.59)	
After the release of mosquitoes more people will die from malaria (Negative)	Strongly agree	50 (11.06)	14 (8.75)	0.165
	Agree	58 (12.83)	13 (8.13)	
	Disagree	344 (76.11)	133 (83.13)	
SIT is a good method because it acts as an additional malaria control tool (Positive)	Strongly agree	190 (42.04)	76 (47.50)	0.022
	Agree	196 (43.36)	74 (46.25)	
	Disagree	66 (14.60)	10 (6.25)	
I like SIT because the released sterile males do not bite (Positive)	Strongly agree	149 (33.04)	56 (35.00)	0.895
	Agree	240 (53.22)	82 (51.25)	
	Disagree	62 (13.75)	22 (13.75)	

Table 2 (continued)

Knowledge items (anticipated/correct response)	Response option	Actual response by exposure category (% of respondents/option)		p-value
		not exposed	exposed	
Acceptability items				
I do not have a problem with the release of sterile males in my community	Strongly agree	183 (40.49)	72 (45)	0.306
	Agree	235 (51.99)	81 (50.63)	
	Disagree	34 (7.52)	7 (4.38)	
I believe that the community is happy about SIT technology for malaria elimination	Strongly agree	179 (39.60)	52 (32.50)	0.133
	Agree	221 (48.89)	93 (58.13)	
	Disagree	52 (11.50)	15 (9.38)	
The sterilized mosquitoes will not interfere with our day-to-day activities	Strongly agree	146 (32.30)	49 (30.63)	0.923
	Agree	175 (38.72)	64 (40.00)	
	Disagree	131 (28.98)	47 (29.28)	
I am looking forward to the release of sterilized male mosquitoes in my area	Strongly agree	140 (30.97)	53 (33.13)	0.003
	Agree	264 (58.41)	104 (65.00)	
	Disagree	48 (10.62)	3 (1.88)	
SIT is an acceptable way to control malaria in the community	Strongly agree	193 (42.70)	74 (46.54)	0.385
	Agree	195 (43.14)	69 (43.40)	
	Disagree	64 (14.16)	16 (10.06)	

Table 3 Factors associated with acceptance of SIT in KwaZulu-Natal, South Africa (all models were adjusted for age and education)

Variables (N = 611)	Exposure, Model 1		Knowledge items, Model 2		All items Model 3	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Exposure						
No	Ref.					
Yes	0.64 (0.44–0.99)	0.020	0.66 (0.46–0.97)	0.036	0.65 (0.45–0.94)	0.026
Age categories						
18–35	Ref.					
36–50	0.80 (0.54–1.18)	0.269	0.79 (0.53–1.18)	0.257	0.76 (0.51–1.12)	0.172
51 +	0.86 (0.57–1.30)	0.497	0.90 (0.58–1.40)	0.664	0.85 (0.56–1.28)	0.442
Education						
No schooling	Ref.					
Primary level	1.06 (0.60–1.87)	0.820	1.10 (0.62–1.97)	0.729	1.08 (0.61–1.92)	0.776
Secondary level and above	1.60 (0.97–2.64)	0.064	1.65 (0.98–2.76)	0.056	1.64 (0.98–2.73)	0.056
Knowledge items						
Female mosquitoes do not bite	–		1.10 (0.67–1.80)	0.691	–	–
Female mosquitoes feed on blood	–		0.45 (0.22–0.92)	0.030	0.47 (0.23–0.94)	0.034
SIT targets mosquitoes that feeds and rests indoors only	–		0.74 (0.46–1.19)	0.227	–	
SIT will replace the indoor residual spraying	–		1.02 (0.65–1.59)	0.917	–	
Attitude items						
SIT is a good method because it acts as an additional malaria control tool	–		–	–	0.69 (0.48–0.97)	0.034

profile reported in census and local health data for Jozini [24]. However, individuals who were employed, mobile, or less available during daytime data collection may be under-represented. Similarly, studies in Kenya and Nigeria reported on CE evaluations where daytime outreach missed employed adults, resulting in lower exposure among working-age men and women [27, 28]. This potential under-representation may have implications for

generalizability, particularly in interpreting exposure to CE formats.

Participants who were exposed to arts-based CE interventions demonstrated better understanding of key entomological concepts, particularly regarding the role of sterile male mosquitoes and the safety of SIT. This suggests that the arts-based strategies were successful in communicating complex scientific ideas in an accessible and culturally appropriate manner. The use of music, storytelling, and drama may have reinforced learning by tapping into familiar oral traditions and everyday language, particularly for audiences with varying levels of formal education. Comparable outcomes have been reported elsewhere. For instance, in The Gambia, McConnell and colleagues used a participatory song intervention to promote bed net repair and malaria prevention, with 81% of exposed households repairing their bed nets compared to 50% in control villages [15]. Similarly, arts-based HIV/AIDS campaigns in KwaZulu-Natal that employed song and community drama increased awareness, reduced stigma, and improved community dialogue [16, 17]. Studies from Kenya and Nigeria have also shown that theatre-based interventions improved knowledge scores about reproductive health and malaria by more than 20% post-intervention [27, 29].

Although the arts-based CE approaches were well-received in this study, overall exposure levels were low, with roughly one in four participants reporting engagement with at least one arts-based CE tool. Among those reached, many had encountered more than one format, such as a combination of music, radio short stories, and school drama, highlighting the benefits of using multiple formats to deliver key messages. This aligns with evidence from a community radio-based health education study in Uganda, where repeated exposure to serialized audio episodes led to measurable increases in health-seeking behaviour and antenatal clinic attendance [14].

In this study, women and unemployed individuals reported higher exposure to CE activities compared to other demographic groups. Most CE delivery occurred through schools, community gatherings, and daytime events, meaning employed individuals and younger men were less likely to have engaged with the tools. This pattern mirrors findings from other contexts where CE activities disproportionately reached women, children, and the elderly, while employed or mobile populations were under-represented [27, 29]. Addressing these gaps will require deliberate strategies to improve inclusivity, such as incorporating digital platforms, workplace outreach, and evening or weekend events to reach under-represented groups. Taken together, these findings affirm that arts-based CE strategies, when co-created with communities and disseminated through multiple, accessible, and culturally relevant channels, can serve as effective knowledge translation tools in public health interventions such as the SIT.

In addition to influencing exposure, demographic characteristics also shaped participants' attitudes towards acceptance of SIT. Younger participants and those with higher educational attainment were generally more accepting of SIT, potentially due to greater openness to scientific innovations or a higher baseline understanding of the intervention. However, this observation was not statistically significant. This trend aligns with findings from other vector control and vaccine-related studies, where education level and youth status were linked to more favourable attitudes toward novel health technologies [30, 31]. However, in this study, the strength of association between CE exposure and SIT acceptance remained significant even after adjusting for demographic factors. This suggests that while demographics may influence baseline attitudes, tailored CE tools can help bridge gaps in understanding and foster more uniform community support. These findings reinforce the importance of using engagement formats that are accessible and resonant across demographic groups, not only to increase exposure but to promote equitable uptake of emerging public health interventions.

Beyond increasing knowledge, the arts-based CE interventions appeared to positively influence participants' attitudes toward the SIT. Those who were exposed to the materials were more likely to express confidence in the safety of sterile mosquitoes, view the technology as beneficial for their community, and support its use alongside existing malaria control methods. These attitudes are critical, given that the success of vector control technologies like the SIT often depends on public co-operation and trust. Evidence from other settings shows that arts-based CE approaches helped in optimising public health interventions through directly shaping attitudes and behaviours towards these interventions [12, 16, 17]. Arts-based CE strategies built trust by embedding messages in familiar cultural idioms, using relatable characters, and offering opportunities for dialogue. The use of creative media may offer a unique advantage in shaping attitudes because it evokes emotion, stimulates imagination, and normalizes new ideas. Arts-based engagement, by contextualizing scientific interventions within everyday experiences, may help communities move beyond scepticism and toward collective ownership of public health solutions.

Knowledge plays a pivotal role in shaping the outcomes of CE initiatives, particularly for novel public health interventions such as the SIT. Evidence from malaria and other vector control programmes shows that communities are more likely to support and adopt

new technologies when they understand how they work, perceive them as safe, and see their complementarity to existing measures [8]. In this study, participants who correctly understood that sterile male mosquitoes do not bite and that SIT is designed to complement, rather than replace, current malaria control strategies were more inclined to accept the technology. This supports CE theory, which holds that acceptability depends not only on information but also on reassurance, respect, and empowerment [32]. Exposure to arts-based CE was also positively associated with SIT acceptance, even after accounting for socio-demographic factors, underscoring the role of culturally relevant messaging in fostering social buy-in. Comparable examples in the literature strengthen this interpretation. In The Gambia, a participatory song was used as a CE tool to promote the importance of repairing bed nets. This approach not only enhanced knowledge but also encouraged households to take action, leading to more nets being repaired [15]. In KwaZulu-Natal, choral performances and interactive drama targeting HIV/AIDS stigma led to attitude change that enhanced public support for testing and disclosure [17]. These outcomes illustrate how arts-based engagement does more than inform; it fosters a collective sense of ownership, makes abstract risks tangible, and helps to normalize novel interventions through emotionally resonant storytelling and performance.

In this context, the observed association between exposure to arts-based CE, knowledge, and acceptance of SIT suggests that these tools supported participants in developing clearer understandings and more positive perspectives on the technology. By reducing uncertainty and presenting SIT within the context of familiar malaria prevention strategies, arts-based CE encouraged constructive discussion and consideration of its potential role. Similar patterns have been observed in Kenya [33] and South Africa [34], who found that using local language, cultural references, and interactive formats such as music and drama improved comprehension and stimulated community dialogue, contributing to receptivity toward new health interventions. This study contributes to the growing body of evidence supporting the need for systematic evaluation of CE strategies, especially before they are institutionalized or scaled up.

While arts-based approaches are frequently praised for being engaging and culturally relevant [8, 12, 14], there is often limited evidence demonstrating whether they meet their intended outcomes of improving knowledge, shifting attitudes, and increasing acceptance. These findings provide this missing link: exposure to co-developed, locally resonant CE tools was associated with higher levels of SIT knowledge and acceptance, validating their potential as effective engagement strategies in public health.

Effective community engagement often relies on multi-modal delivery, where messages are disseminated through several complementary channels to reinforce understanding and retention. Using diverse formats such as drama, radio, and music can engage different audience segments, accommodate varying literacy levels, and sustain attention over time. This study suggests that participants who encountered messages through multiple arts-based formats, such as school drama, radio short stories, and music, demonstrated better understanding of the SIT, highlighting the added value of reinforcing messages across complementary channels.

Evidence from similar contexts demonstrates that multi-channel strategies enhance the reach and impact of public health interventions [32, 35]. For instance, radio serial dramas have been shown to increase audience identification with characters, reinforce key messages, and improve retention, as exemplified by the Shuga edutainment series, which contributed to increased HIV testing and contraceptive use among youth in East and Southern Africa [35]. Similarly, folk theatre and participatory community drama have improved awareness and uptake of vector control measures in dengue-endemic regions, demonstrating that combining storytelling, performance, and broadcast media strengthens message dissemination and audience engagement [36].

Strengths and limitations

This study contributes meaningful evidence on the value of arts-based CE in promoting understanding and acceptance of novel vector control methods. A key strength lies in its integration with a real-world public health initiative, the South African SIT project, allowing for practical insights into the feasibility and impact of CE tools developed in partnership with local communities. The sample size was large and drawn from multiple villages in a malaria-endemic area, enhancing the generalizability of the findings within the KwaZulu-Natal context. Furthermore, the use of multivariable ordinal regression allowed for adjustment of potential confounding factors, strengthening the observed associations between exposure, knowledge, attitudes, and SIT acceptability.

However, several limitations must be acknowledged when interpreting these findings. First, individuals who were employed or otherwise unavailable during daytime data collection may have been underrepresented, resulting in sampling bias. Secondly, the reliance on self-reported data may introduce recall and social desirability bias, where participants provided responses that they believed were expected. Thirdly, the study was conducted in a specific geographic area, which may limit the

generalizability of the findings to other malaria-endemic regions with different sociocultural contexts. Lastly, the high overall agreement on the acceptability of SIT may have limited the ability to detect differences between groups, warranting further investigation.

Conclusion

The findings from this study demonstrate that arts-based CE approaches co-developed with communities and delivered through culturally resonant formats can contribute to increased knowledge and more favourable attitudes toward novel public health interventions such as SIT. Exposure to song, radio storytelling, and school-based drama was positively associated with community understanding of the SIT method and with acceptance of its use in malaria control. These results offer support for the continued investment in creative and participatory CE strategies, especially in contexts where public buy-in is critical to the success of innovative vector control approaches.

To maximize their impact, it is recommended that arts-based CE approaches must be widely disseminated, consistently reinforced, and evaluated not only for engagement quality but also for their effects on comprehension and decision-making. To build on these findings, future research and programme implementation should explore opportunities for scaling, prioritize co-designed, multi-channel CE strategies, particularly those that combine cultural relevance with broad accessibility through digital, community, and educational platforms to reach broader and more diverse segments of malaria-affected communities.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12936-025-05678-y.

Supplementary Material 1

Supplementary Material 2

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Author contributions

PNM conceptualized and designed the study tools, conducted interviews, analysed and interpreted the data, wrote the first and subsequent drafts of the manuscript. SJ and GM participated in the conception of the work, supervised and contributed to the subsequent interpretation and writing of the manuscript. All authors read and approved the final manuscript.

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Data availability

All data is available on reasonable request.

Declarations

Ethics approval and consent to participants

We obtained ethical approval from the Faculty of Health Sciences Research Ethics Committee of the University of the Witwatersrand (M220258) in March 2022 and KwaZulu-Natal Health Research and Knowledge Management (KZ_202203_031). The Chief, the malaria office, and the different schools also provided permission and support letters. The study process and the consent form were explained to all participants in their native language (i.e. IsiZulu), and participants gave written permission to participate. Participants were informed that it was strictly voluntary to participate and that they could withdraw from the study at any time without giving a reason.
Individual interviews were held in a private setting outside the participant's household. Unique personal identifiers were used. Consent forms were stored as hard copies in sealed boxes in the researcher's office as well as electronically on a PIN-enabled hard drive.

Consent for publication

Not applicable.

Competing interest

The authors declare no competing interests.

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