Society of Medical Education & Research

2022, Volume 2, Issue 2, Page No: 64-74
ISSN: 3108-4826

Journal of Medical Sciences and Interdisciplinary Research

Household Visits Versus Incentive Programs for Tuberculosis Contact Tracing: Implementation Outcomes from Rural South Africa

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Abstract

The World Health Organization recommends tuberculosis (TB) contact investigation in countries with a high TB burden. This study evaluated the implementation reach of two distinct contact investigation approaches in South Africa. The Kharitode TB trial, a cluster-randomized crossover study, compared household-based versus incentive-based contact investigation across 28 clinics from July 2016 to January 2020. Each clinic implemented both strategies sequentially for 18 months, with a six-month washout period in between. Adults with a recent TB diagnosis (index participants) were eligible for enrollment. In the household-based strategy, community health workers visited homes to screen contacts and collect sputum samples on-site. In the incentive-based strategy, index participants received referral coupons to distribute to their contacts, who were offered a $3.50 incentive upon attending the clinic for TB screening. Mixed-effects logistic regression models, incorporating random intercepts for clinics, were used to identify factors associated with index participant enrollment and successful sputum collection from contacts. In the household-based arm, 782 of 1,269 eligible index participants (61.6%) provided consent, leading to the enrollment of 1,882 contacts; sputum samples were obtained from 988 of these contacts (52.5%). In the incentive-based arm, 780 of 1,295 eligible index participants (60.2%) consented, resulting in 1,940 enrolled contacts and sputum collection from 1,431 (73.8%). Index participants with HIV (adjusted odds ratio [aOR] 0.56, 95% CI 0.38–0.83) or unknown HIV status (aOR 0.12, 95% CI 0.07–0.20) were significantly less likely to enroll in the study. Contacts in the incentive-based arm had substantially higher odds of providing a sputum sample than those in the household-based arm (aOR 2.12, 95% CI 1.80–2.50). Across both arms, factors independently associated with greater likelihood of sputum submission included presence of cough (aOR 2.27, 95% CI 1.87–2.77), current smoking (aOR 2.22, 95% CI 1.63–3.02), and known HIV-positive status (aOR 1.89, 95% CI 1.36–3.62). Notable implementation gaps were observed at multiple stages, including outreach and enrollment of index participants, engagement of people living with HIV, and sputum collection—particularly among contacts under 18 years of age and those identified through household visits.

Keywords: Household visits, Incentive programs, Tuberculosis, HIV

Introduction

Tuberculosis (TB) continues to be the top cause of morbidity and mortality from a single infectious pathogen worldwide [1]. In 2023, an estimated 10.8 million people developed TB, leading to 1.25 million deaths [1]. Although rapid and accurate diagnostic tests exist, only 8.2 million new TB cases were officially diagnosed and reported to health authorities [1]. Addressing the remaining 2.6 million undiagnosed cases is a major global TB control challenge, as delayed diagnosis and treatment perpetuate transmission. Individuals living with or in close contact with someone with TB—termed contact persons—face a substantially higher risk of infection and progression to disease [2]. For this reason, the World Health Organization (WHO) advises systematic TB contact investigation in high-burden settings to identify TB cases early among contacts [3, 4].

Access this article online https://smerpub.com/

Received: 23 April 2022; **Accepted:** 04 August 2022

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How to cite this article: Hansen NE, Kristoffersen MT. Household Visits Versus Incentive Programs for Tuberculosis Contact Tracing: Implementation Outcomes from Rural South Africa. J Med Sci Interdiscip Res. 2022;2(2):64-74. https://doi.org/10.51847/FiR6o7PJ7Y

Implementing contact investigation involves multiple stages and requires the interaction of several factors, including the ability to locate and engage contacts and the accessibility of diagnostic testing, as well as collaboration among diverse stakeholders such as clinicians, outreach personnel, and people living with TB [5–7]. Because of this complexity, the effectiveness and cost-effectiveness of contact investigation programs in high-burden areas have shown considerable variation [2]. Evaluating implementation reach—defined as the proportion of targeted individuals successfully engaged at each stage of an intervention [8]—can offer critical insight into barriers affecting TB contact investigation, yet it is rarely assessed alongside intervention effectiveness. This study aims to examine implementation reach, measured as the proportion of individuals completing each step of the contact investigation cascade, comparing a traditional household-based approach with an innovative incentive-based strategy within a cluster-randomized trial conducted in South Africa [9–11].

Materials and Methods

Study design

This paper reports a secondary analysis from the Kharitode TB cluster-randomized trial, which investigated tuberculosis (TB) case-finding approaches in Limpopo Province, South Africa, conducted between July 18, 2016, and January 17, 2020. The original trial evaluated the comparative effectiveness of facility-based TB screening versus contact investigation strategies—specifically, household-based and incentive-based approaches—using the number of new treatment initiation and TB diagnoses as the primary endpoints. A detailed account of the trial methodology has been published elsewhere [9, 10]. In summary, 56 public primary care clinics were randomized equally to either standard facility-based screening or a contact investigation strategy. Among clinics assigned to contact investigation, sites were further categorized based on whether they implemented the traditional household-based method or a novel incentive-driven approach. This analysis focuses exclusively on participants and outcomes within the contact investigation arm.

Local context

South Africa faces a high burden of tuberculosis (TB), with an estimated 513 new cases per 100,000 population in 2021 [12]. The population is roughly evenly split between urban and rural settings, and frequent seasonal labor migration complicates contact tracing and influences patterns of TB transmission [13]. The Kharitode TB trial was conducted in the rural districts of Vhembe and Waterberg in Limpopo Province. Despite low population densities in these areas (<50 people/km²), TB incidence and prevalence remain elevated, reflecting factors such as socioeconomic deprivation, malnutrition, and limited access to healthcare due to long travel distances and transportation challenges [14, 15].

Contact eligibility criteria and investigation strategies

In this study, contact investigation was conducted in 28 clinics, with half initially implementing a household-based strategy and the other half using an incentive-based approach. Each clinic applied its assigned strategy for 18 months, followed by a six-month pause, after which it switched to the alternate strategy for another 18 months. Data from both intervention periods are included in this analysis. All individuals newly diagnosed with TB and initiating treatment within two months of the study start, along with their contacts, were considered eligible for enrollment, independent of age or diagnostic method. Identification of potential index participants relied on clinic TB treatment registers, including both electronic and paper records.

For the household-based strategy, the team first attempted to reach potential index participants via up to three phone calls at varied times and days. If participants could not be contacted by phone, home visits were conducted. Once consented, a household visit was scheduled to screen contacts. Each consenting contact underwent assessment using the WHO four-symptom screen (cough, fever, weight loss, or night sweats) [16], and sputum samples were collected regardless of symptom presence. Staff made up to three visits to ensure all household contacts were screened. Participants received reimbursement for their time spent participating in the study.

In the incentive-based arm, index participant recruitment followed the same procedures as the household-based approach. Each participant received 10 referral coupons to share with household members, friends, or coworkers. Coupons included the clinic location, operating hours, and a unique identifier linking the contact to the index participant. Contacts presenting to the clinic within two months of index enrollment received 50 South African Rand (ZAR, ~3.50 USD). Index participants were

compensated 20 ZAR (~1.50 USD) for each referred contact screened and 100 ZAR (~7.00 USD) for each contact diagnosed with TB. Clinic-based contacts underwent the WHO four-symptom screening [16] and provided sputum samples.

Across both strategies, sputum specimens were transported by study staff to the clinics and then sent to the National Health Laboratory Services via routine transport routes for Xpert MTB/RIF testing [17]. Results were retrieved from the electronic laboratory system, and participants were informed of their results either during household visits or by telephone. The overall process for both contact investigation strategies is summarized in **Figure 1.**

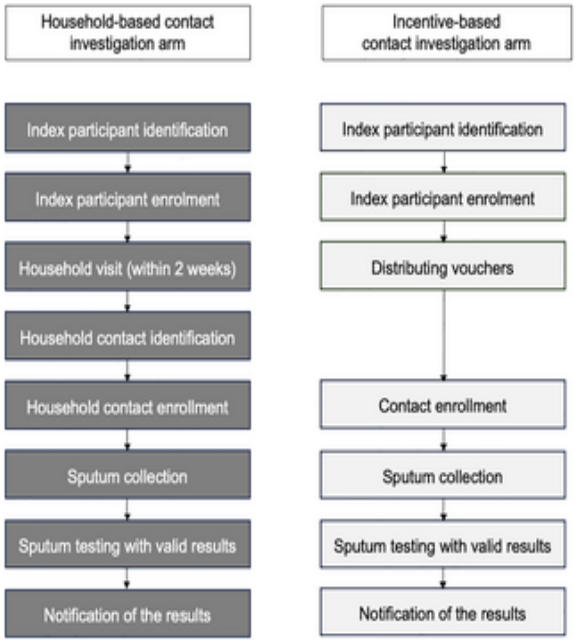

Figure 1. Presents a flowchart illustrating the contact investigation procedures for both the household-based and incentive-based approaches.

Data were captured using a mix of paper-based records and digital systems to track progress at every stage of the implementation cascade for each contact tracing strategy. Demographic and clinical details of potential index participants (such as age, sex, and HIV status) were extracted from clinic records, while information on contact persons was gathered via self-administered questionnaires.

Study objectives

This analysis sought to assess the implementation reach of the two contact investigation approaches by determining the enrollment rates of index participants and comparing differences in contact enrollment and sputum submission between the household- and incentive-based strategies. We further examined sociodemographic and clinical factors linked to successful engagement of both index participants and their contacts.

Outcomes measuring implementation reach

Implementation reach was defined operationally by quantifying completion rates at successive stages of the contact investigation pathway. Key metrics included: (1) the percentage of eligible TB-diagnosed individuals enrolled as index participants within two months of diagnosis; (2) the percentage of enrolled index participants with at least one contact screened for TB; (3) the percentage of screened contacts who submitted a sputum specimen; (4) the percentage of submitted specimens that underwent testing and yielded a valid result; and (5) the percentage of contacts who received notification of their Xpert MTB/RIF test results.

Statistical analysis

To describe implementation reach, we first computed the enrollment rate of index participants within two months post-diagnosis, using the total number of identified eligible individuals across both arms as the denominator. Data from the two 18-month intervention phases were pooled, given that this descriptive secondary analysis focused on overall reach rather than comparative effectiveness.

We then determined the proportion of enrolled index participants who had at least one contact screened. Among screened contacts, we reported rates for: (1) sputum specimen submission, (2) specimen testing, (3) obtaining valid test results, and (4) successful delivery of Xpert results.

Factors associated with participation were investigated using multivariable mixed-effects logistic regression models that included a random intercept for clinic to adjust for clustering. For index participants, the dependent variable was provision of consent, with predictors comprising sex, age, district, and HIV status. Separately by arm, we evaluated the probability that enrolled index participants had at least one contact enrolled. For contacts, the outcome was sputum submission, with predictors including sex, age, district,

reported symptoms, smoking history, and HIV status. The intervention arm was incorporated as a fixed effect in models to evaluate arm-specific differences while controlling for clinic-level clustering. Analyses were performed using R software version 4.4.1 [18].

De-identified datasets were accessed for this research from September 12, 2023, to May 3, 2025.

Ethical considerations

Ethical approval was granted by the Human Research Ethics Committee (HREC) of the University of the Witwatersrand, South Africa (approval number #00001223). The Johns Hopkins Bloomberg School of Public Health Institutional Review Board authorized deference to the Witwatersrand HREC for primary ethical review and ongoing monitoring. Written informed consent was secured from every participant, with the consent protocol endorsed by the Witwatersrand HREC. The study is listed on ClinicalTrials.gov as NCT02808507.

Results and Discussion

The research team identified a total of 2,563 newly diagnosed TB cases as candidate index cases across the two study phases, successfully recruiting 1,562 (60.9%) of them. Recruitment proportions were nearly identical between the two strategies (61.6% household-based vs. 60.3% incentive-based), with adjusted comparisons presented in the regression results that follow.

Main barriers to recruitment involved reaching the limit of outreach efforts, failure to gain consent (often due to mortality, serious illness, migration, or repeated absence), and direct refusals. The predominant issue was depletion of outreach attempts, impacting 439 candidates (17.1%) overall—specifically 189 (14.9%) in the household arm and 250 (19.3%) in the incentive arm. Active refusals accounted for 190 individuals (7.4%), occurring more frequently in the household arm (116 cases; 9.1%) than the incentive arm (74 cases; 5.7%).

Table 1 outlines the baseline features of candidate index cases who were contacted by the team and subsequently either agreed or refused to join, broken down by intervention strategy. Profiles were broadly consistent across strategies, though the incentive arm achieved a higher consent rate among those reached (91.3% vs. 87.1% in the household arm).

In unadjusted analyses, candidates from Waterberg District showed lower recruitment odds compared to Vhembe District residents, but this effect disappeared after multivariable adjustment. The multivariable mixed-effects model revealed greater enrollment success in the incentive arm (adjusted odds ratio [aOR] 1.58, 95% CI 1.14–2.17). Candidates known to be HIV-positive (aOR 0.56, 95% CI 0.38–0.83) or with undocumented HIV status (aOR 0.12, 95% CI 0.07–0.20) displayed substantially lower enrollment likelihood relative to HIV-negative individuals. No evidence emerged of an interaction between HIV status and intervention arm (**Table 2**).

Table 1. Baseline characteristics of candidate index cases contacted by the study team who either agreed to participate or refused, presented by intervention strategy.

Characteristic	Household-based arm (N = 898)	Incentive-based arm (N = 854)	Total (N = 1752)
Female	371 (41.3%)	361 (42.3%)	732 (41.8%)
Age, years, mean	39.51 (14.92)	38.95 (15.91)	39.24 (15.41)
Aged 18 years or older	850 (95.0%)	786 (92.6%)	1636 (93.8%)
District: Vhembe	390 (43.4%)	365 (42.7%)	755 (43.1%)
District: Waterberg	508 (56.6%)	489 (57.3%)	997 (56.9%)
HIV status: Negative	323 (36.0%)	314 (36.8%)	637 (36.4%)
HIV status: Positive	513 (57.1%)	493 (57.7%)	1006 (57.4%)
HIV status: Unknown	62 (6.9%)	47 (5.5%)	109 (6.2%)
Participated in the study	782 (87.1%)	780 (91.3%)	1562 (89.2%)

Table 2. Participant characteristics linked to successful enrollment among potential index participants (total N = 1,744).

Variable	Category	Crude OR	95% CI	Adjusted OR	95% CI
Sex	Female	Ref		Ref	
	Male	0.90	0.66 – 1.23	0.89	0.64 – 1.23

Age	< 18 years	Ref			
	≥ 18 years	0.65	0.31 – 1.36	0.56	0.26 – 1.26
Study arm	Household-based arm	Ref		Ref	
	Incentive-based arm	1.65	1.21 – 2.26	1.58	1.14 – 2.17
District	Vhembe	Ref		Ref	
	Waterberg	0.77	0.51 – 1.16	0.82	0.53 – 1.27
HIV status	Negative	Ref		Ref	
	Positive	0.55	0.37 – 0.80	0.56	0.38 – 0.83
	Unknown	0.12	0.07 – 0.20	0.12	0.07 – 0.20

Mixed-effects logistic regression with a random intercept for clinic was adjusted for age, sex, arm, HIV and district status. CI=confidence interval; aOR=adjusted odds ratio; OR=odds ratio.

Figure 2 illustrates the implementation reach cascade for both incentive-based and household- contact investigation strategies. In the household-based arm, 782 of the 1,269 identified TB patients (61.6%) agreed to participate. Household visits were conducted for 766 (60.4%) of these enrolled index participants. At least one contact was screened in 519 households (40.9% of households with an enrolled index participant). From these households, a total of 1,882 contacts were enrolled. Sputum samples were successfully collected from 988 contacts (52.5%), with 978 specimens (52.0%) processed for testing and 898 (47.7%) yielding valid results. Ultimately, 953 contacts (50.6%) received notification of their Xpert MTB/RIF results. Among adult contacts (aged 18 years or older), sputum samples were obtained from 615 of 980 individuals (62.8%).

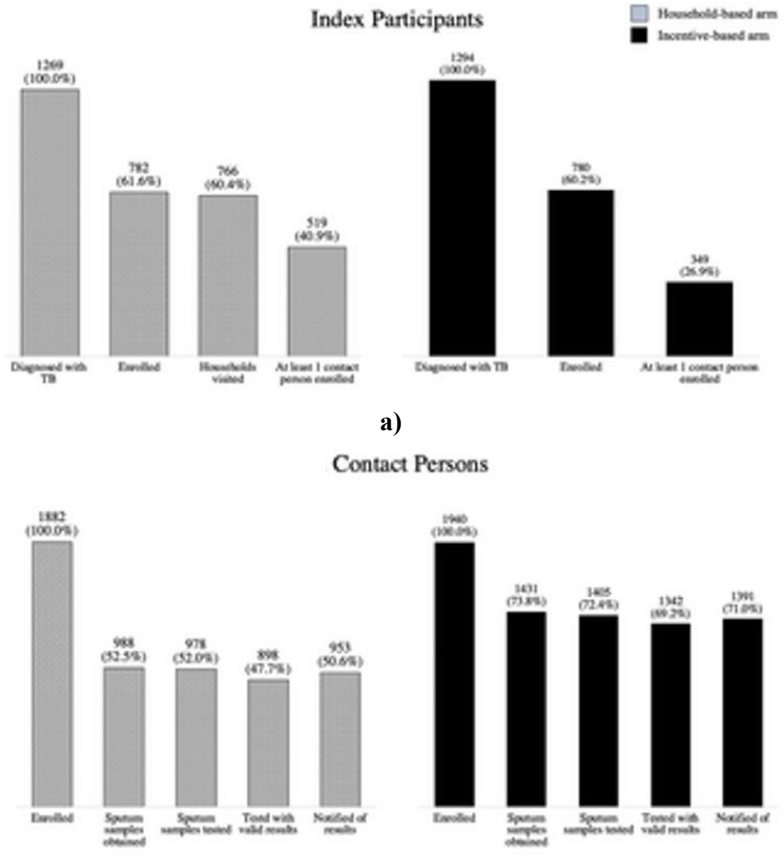

Figure 2. Implementation reach cascade for household- and incentive-based tuberculosis contact investigation strategies.

In the incentive-based contact investigation strategy, 780 of the 1,295 identified TB patients (60.2%) enrolled in the study, and each received referral coupons. Screening at clinics was completed for contacts of 349 index participants, representing 26.9% of enrolled participants. Among these contacts, 1,431 individuals (73.8%) provided sputum samples. Of these samples, 1,405 (72.4%) were processed, and 1,342 (69.2%) yielded valid Xpert MTB/RIF results. The study team successfully communicated test results to 1,391 contacts (71.0%). Comparing overall implementation, 50.6% of contacts in the household-based arm and 71.0% in the incentive-based arm completed the full cascade of screening, testing, and result notification.

Analysis of index participant characteristics revealed that male participants were less likely to have at least one contact enrolled, both in the household-based arm (aOR = 0.60, 95% CI 0.43–0.83) and the incentive-based arm (aOR = 0.65, 95% CI 0.48–0.89). Additional factors associated with lower contact enrollment included residence in Waterberg District in the household-based arm (aOR = 0.34, 95% CI 0.23–0.48) and being under 18 years old in the incentive-based arm (aOR = 0.34, 95% CI 0.18–0.62)0.

Characteristics of contacts according to whether sputum was collected are shown in **Table 3**. In adjusted models, contacts in the incentive-based arm were significantly more likely to provide a sputum sample than those in the household-based arm (aOR = 2.12, 95% CI 1.80–2.50). Across both arms, adults (≥18 years) were nearly three times more likely to submit a sample (aOR = 2.93, 95% CI 2.33–3.68), while those reporting cough (aOR = 2.27, 95% CI 1.87–2.77), current smokers (aOR = 2.22, 95% CI 1.63–3.02), and individuals living with HIV (aOR = 1.89, 95% CI 1.36–2.62) also showed higher likelihood of sputum collection. By contrast, residing in Waterberg District reduced the odds of providing a sample (aOR = 0.28, 95% CI 0.22–0.35) **(Table 4).** No statistically significant interactions were observed between study arm and selected covariates, including sex, HIV status, or district.

Table 3. Characteristics of contact persons.

Characteristic	Household-based Arm			Incentive-based Arm		
	Sputum not collected (N = 902)	Sputum collected (N = 988)	Total (N = 1890)	Sputum not collected (N = 511)	Sputum collected (N = 1431)	Total (N = 1942)
Female, n (%)	553 (61.3%)	607 (61.7%)	1160 (61.5%)	306 (59.9%)	814 (58.1%)	1120 (58.6%)
Age ≥ 18 years, n (%)	365 (41.9%)	615 (62.5%)	980 (52.8%)	204 (41.4%)	1088 (77.7%)	1292 (68.3%)
Vhembe district, n (%)	369 (40.9%)	612 (62.2%)	981 (52.0%)	162 (31.7%)	728 (52.0%)	890 (46.6%)
Waterberg district, n (%)	533 (59.1%)	372 (37.8%)	905 (48.0%)	349 (68.3%)	672 (48.0%)	1021 (53.4%)
Tuberculosis Symptoms:						
Cough, n (%)	138 (15.3%)	278 (28.3%)	416 (22.1%)	108 (21.1%)	472 (33.7%)	580 (30.0%)
Fever, n (%)	57 (6.5%)	66 (6.7%)	123 (6.5%)	32 (6.3%)	137 (9.8%)	169 (8.8%)
Weight loss, n (%)	46 (5.1%)	59 (6.0%)	105 (5.6%)	32 (6.3%)	168 (12.0%)	200 (10.5%)
Night sweats, n (%)	70 (7.8%)	89 (9.0%)	159 (8.4%)	47 (9.2%)	249 (17.8%)	296 (15.5%)
Other*, n (%)	120 (13.4%)	184 (18.7%)	304 (16.2%)	91 (17.2%)	353 (25.3%)	444 (23.3%)
Smoking Status						
Never smoker, n (%)	825 (92.4%)	843 (85.7%)	1668 (88.9%)	467 (91.7%)	989 (70.7%)	1456 (76.3%)

Yes, n (%)	45 (5.0%)	104 (10.6%)	149 (7.9%)	30 (5.9%)	321 (22.9%)	351 (18.4%)
Not currently, but formerly, n (%)	22 (2.5%)	34 (3.5%)	56 (3.0%)	10 (2.0%)	84 (6.0%)	94 (4.9%)
Declined to disclose, n (%)	1 (0.1%)	3 (0.3%)	4 (0.2%)	2 (0.4%)	5 (0.4%)	7 (0.4%)
HIV negative, n (%)	702 (77.8%)	778 (79.1%)	1480 (78.5%)	273 (53.6%)	779 (55.7%)	1052 (55.1%)
HIV positive, n (%)	42 (4.7%)	53 (5.4%)	95 (5.0%)	21 (4.1%)	185 (13.2%)	206 (10.8%)
Declined to disclose/unknown, n (%)	158 (17.5%)	153 (15.5%)	311 (16.5%)	217 (42.5%)	436 (31.1%)	653 (34.2%)

*Additional symptoms reported included genital or urinary issues, pain in other body areas, chest discomfort, gastrointestinal problems, and skin conditions.

Table 4. Characteristics linked to sputum sample submission among contact persons, stratified by study arm.

Variable	Category	Crude OR	95% CI	Adjusted OR	95% CI
Sex	Female	Ref		Ref	
	Male	1.05	0.91 – 1.20	1.05	0.88 – 1.25
Study arm	Household-based arm	Ref		Ref	
	Incentive-based arm	2.67	2.31 – 3.08	2.12	1.80 – 2.50
District	Vhembe district	Ref		Ref	
	Waterberg district	0.42	0.33 – 0.53	0.28	0.22 – 0.35
Age	< 18 years	Ref		Ref	
	≥ 18 years	3.99	3.44 – 4.64	2.93	2.33 – 3.68
Fever	No reported fever	Ref		Ref	
	Fever	1.69	1.29 – 2.21	0.96	0.69 – 1.33
Cough	No reported cough	Ref		Ref	
	Cough	2.36	1.99 – 2.79	2.27	1.87 – 2.77
Night sweats	No reported night sweats	Ref		Ref	
	Night sweats	2.00	1.59 – 2.52	1.00	0.76 – 1.32
Weight loss	No reported weight loss	Ref		Ref	
	Weight loss	2.28	1.73 – 3.00	1.11	0.80 – 1.54
HIV status	Negative	Ref		Ref	
	Positive	2.45	1.82 – 3.30	1.89	1.36 – 2.62
	Declined/unknown	1.02	0.87 – 1.20	1.12	0.93 – 1.35
Smoking status †	Never smoker	Ref		Ref	
	Current smoker	5.02	3.84 – 6.57	2.22	1.63 – 3.02
	Former smoker	3.05	2.02 – 4.59	1.37	0.88 – 2.13

Mixed-effects logistic regression analyses accounted for clustering by including a random intercept for each clinic and were controlled for participant sex, study arm, district of residence, age, smoking behavior, TB-related symptoms, and HIV status.

† This category includes individuals who reported never smoking as well as those who did not provide information on their smoking habits. Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio.

Optimizing the delivery of TB contact investigation remains critical to improving its overall impact, yet very few studies in high-burden settings have reported on practical implementation outcomes [19–23]. In this study, we compared household-based and incentive-based strategies and found substantial differences in contact screening coverage. Overall, fewer than half of index participants had at least one contact screened, with the incentive-based strategy reaching only 27%

compared to 41% in the household-based approach. Nevertheless, among contacts who did engage, the incentive-based approach demonstrated higher implementation fidelity, with more than two-thirds receiving their Xpert MTB/RIF results compared with approximately half in the household-based arm.

Enrollment of index participants was limited, with fewer than two-thirds consenting to participate. The principal barrier was difficulty in reaching participants, whether by phone or during home visits. Factors contributing to this included lack of personal phones, frequently changing phone numbers, temporary work-related migration, and challenges locating households without formal addresses [10, 24]. Similar obstacles have been documented in other contexts, including India, where limited phone access hinders TB program implementation [25], and Uganda, where shared phone use and malfunctioning devices impeded follow-up [20].

Participants living with HIV, as well as those with unknown HIV status, were less likely to enroll compared with HIV-negative individuals. This may reflect the pervasive stigma surrounding HIV and TB in South Africa, where dual diagnosis carries considerable social consequences [26]. HIV and TB stigma frequently overlap, leading to delays in care-seeking and suboptimal TB treatment outcomes [27–31]. Interestingly, contacts with HIV in the incentive-based arm were more likely to provide sputum than those in the household-based arm. Possible reasons include the presence of more pronounced symptoms and the enhanced privacy provided by clinic-based sample collection, which may reduce stigma-related concerns.

The study also revealed notable differences in sputum collection between arms. In the incentive-based strategy, approximately 80% of contacts provided sputum, similar to active case-finding programs in Peru [21, 32], while household-based collection yielded valid sputum samples from just over half of contacts. This discrepancy may be influenced by both personnel and setting; lay health workers collected sputum at homes, whereas trained TB healthcare staff supervised clinic-based collection. Household environments may lack private spaces suitable for sample collection, which has been reported as a barrier in Uganda, where only 39% of household contacts provided sputum due to insufficient secluded collection areas [33].

Children represented a higher proportion of contacts in the household-based arm, which likely contributed to lower sputum collection. Adults were nearly three times more likely to provide samples than children, who often struggle to produce sufficient sputum despite their elevated TB risk [34]. Alternative specimen collection methods, such as oral swabs, may help overcome this limitation for both children and adults unable to expectorate, although their diagnostic accuracy remains suboptimal [35]. Even after adjusting for age, incentive-based contacts were twice as likely to provide sputum, highlighting the influence of collection environment and supervision.

We did not directly measure how effectively index participants distributed referral coupons in the incentive-based arm. However, fewer than half of index participants had a linked contact, compared with most in the household-based arm. Potential explanations include misunderstanding of the coupon system, reluctance to disclose TB status due to stigma [36, 37], and logistical challenges such as travel distance or insufficient cash incentives. Although small cash incentives have been shown to enhance engagement in TB programs [38–40], their effectiveness may vary depending on the economic context and household income. Prior studies in Uganda suggest that incentives similar to those used here (1.00–3.50 USD) can meaningfully increase participation [41, 42].

This study has several limitations. First, dedicated study staff carried out contact investigations, which may not reflect routine implementation conditions, where staff experience and training vary. Second, the reach of coupon distribution was not directly assessed, although returned coupons provide indirect evidence of participation. Third, ART status was unknown for index participants and contacts living with HIV, preventing evaluation of its potential impact on study engagement. Finally, complementary qualitative research could provide richer insight into participant, provider, and context-specific barriers to TB contact investigation.

Conclusion

This study offers important evidence on the practical reach of TB contact investigation strategies. Implementation was constrained by difficulties in reaching and enrolling index participants, reduced engagement among individuals living with HIV, and obstacles in screening contacts and collecting sputum, especially among children. These results highlight specific operational gaps within the contact investigation process that must be addressed to optimize the

effectiveness of both incentive-based and household strategies.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: None

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