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Lessons learned from community-based tuberculosis case-finding in western Kenya

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Setting: Although Kenya has a high burden of tuberculosis (TB), only 46% of cases were diagnosed in 2016.

Objective: To identify strategies for increasing attendance at community-based mobile screening units.

Design: We analysed operational data from a cluster-randomised trial, which included community-based mobile screening implemented during February 2015–April 2016. Community health volunteers (CHVs) recruited individuals with symptoms from the community, who were offered testing for human immunodeficiency virus (HIV) and sputum collection for Xpert® MTB/RIF testing. We compared attendance across different mobile unit sites using Wilcoxon rank-sum test.

Results: A total of 1424 adults with symptoms were screened at 25 mobile unit sites. The median total attendance among sites was 54 (range 6–134, interquartile range [IQR] 24–84). The median yields of TB diagnoses and new HIV diagnoses were respectively 2.4% (range 0.0–16.7, IQR 0.0–5.3) and 2.5% (range 0.0–33.3, IQR 1.2–4.2). Attendance at urban sites was variable; attendance at rural sites where CHVs were paid a daily minimum wage was significantly higher than at rural sites where CHVs were paid a nominal monthly stipend ($P < 0.001$).

Conclusion: Mobile units were most effective and efficient when implemented as a single event with community health workers who are paid a daily wage.

Approximately 10 million people are estimated to have developed tuberculosis (TB) in 2017, but over a third of these people were missed by health systems.[1] Kenya has an estimated annual TB incidence rate of 319 per 100 000 population;[1] however, around half are not receiving treatment.[2] Strategies to find these missing TB cases are needed to address the TB epidemic in Kenya and worldwide.

One strategy for finding these missing cases is to look for them in community settings, outside health care facilities. Because people who face barriers to accessing the health care system will not reach health facilities, diagnostic services must be brought to them where they live and work. Different approaches for TB active case-finding in community settings have been implemented. In Zimbabwe, mobile vans for sputum collection rotated through suburban communities and tested over 5000 adults with symptoms, 9% of whom were diagnosed with TB.[3] In Papua New Guinea, residents of remote villages were called to community meetings and asked to come forward for evaluation if they had TB symptoms; 8% of the 1700 who came forward were diagnosed with TB.[4] In the Philippines, over 25 000 people were screened using chest radiography regardless of symptoms, 3% of whom were diagnosed with TB.[5] In India, over 8000 people attended the medical units, but because TB diagnostic evaluation was limited to 540 people with symptoms, <1% of attendees were diagnosed with TB.[6]

We need to know the factors that contribute to effective implementation of TB active case-finding in communities. In the present study, we evaluate operational data from community mobile screening units in western Kenya to identify implementation strategies that results in higher attendance and higher yields of new TB and HIV diagnoses.

STUDY POPULATION, DESIGN, AND METHODS

During February 2015–April 2016, community mobile screening units were deployed in parts of Kisumu and Siaya Counties in western Kenya. This region has an adult human immunodeficiency virus (HIV) prevalence of approximately 15%,[7] and an annual TB case notification rate of around 200/100 000.[8] It is estimated that 46% of the country's cases were diagnosed and treated in 2016.[2] Community mobile screening was implemented as part of a cluster-randomized study to assess the impact of different active case-finding strategies on TB case detection. The primary analysis in that study involves the assessment of the impact of mobile units on case notifications and is not discussed here; an analysis of individual-level risk factors for TB diagnosis among mobile unit attendees is published elsewhere.[9] The current manuscript presents a secondary analysis of operational data collected at the mobile screening units to identify implementation strategies for increasing attendance and direct yield.

Intervention

The community-based mobile screening unit strategy was modeled on the DETECTB study,[3] whereby mobile units functioned mainly to collect sputum from adults with symptoms, thus saving them the effort of attending a health facility. Mobile units were deployed at 25 sites (Figure 1). Mobile units visited 20 sites a total of three times, and five sites a total of two times within a 1-year period; each time, the mobile unit was set up at a central site in the community for 2 weeks, and sites were visited in a fixed order to maximise the time between visits to a single site. Mobile units were super-

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vised by a study coordinator, who liaised with the Ministry of Health and local authorities. The target population was adults (age ⩾15 years) with TB symptoms who were residing in the area around the mobile unit.

Starting 2 weeks before the arrival of the mobile unit, community health volunteers (CHVs) operating under the Ministry of Health were tasked with recruiting adults with TB symptoms from the surrounding community. In Kenya, all communities have CHVs attached to them, with each CHV covering 100–120 households; we engaged CHVs who were attached to communities surrounding the mobile unit sites. CHVs were compensated differently depending on the policies of the organisation that handled CHV compensation in each area. CHVs engaged for 15 mobile unit sites were paid 350 Kenyan shillings (KES) for each day of work, while CHVs engaged for seven sites received 1000 KES for each month of work.

All adults attending the mobile units were asked about cough, fever, weight loss, night sweats or difficulty breathing in the past month. People who did not know their HIV status (defined as not having a previous positive test result and not having a negative test within the last 3 months) were offered HIV testing by trained counselors in a private tent at the mobile unit. Individuals newly diagnosed with HIV were referred for HIV care services at a health facility. Study staff collected sputum samples from individuals who were HIV-negative and reported respiratory symptoms, as well as non-HIV-negative individuals (i.e., those who were HIV-positive and those with unknown HIV status) who reported any symptom. Study staff transported samples in coolers to Ministry of Health laboratories, the Kenya Medical Research Institute (KEMRI)/US Army Medical Research Directorate—Kenya Kombewa Clinical Research Center Laboratory, or the KEMRI Tuberculosis Laboratory in Kisumu, Kenya, for evaluation using Xpert® MTB/RIF (Cepheid, Sunnyvale, CA, USA). Individuals with positive Xpert results were contacted and referred to a health facility for treatment. Xpert-negative individuals with persistent symptoms were given referral letters to health facilities for clinical evaluation, and study staff coordinated with staff at the health facility to facilitate linkage to care.

Data analysis

We treated the mobile units, rather than individual patients, as a unit of analysis to identify implementation strategies that resulted in better performance. For analysis, we classified mobile units within the city of Kisumu as urban and sites outside the city as rural. We also classified mobile unit sites according to how the CHVs who served them were compensated (i.e., daily wage vs. monthly stipend). While the same duties were expected of CHVs regardless of payment mechanism, we did not record the number of hours that CHVs actually worked; analysis was therefore based on payment mechanism alone. Finally, we classified each site according to the number of health facilities within a linear distance of 2 km.

We analysed attendance, defined as the number of adults with TB symptoms who attended the mobile unit. We analysed diagnostic yield during the first two visits for sites that screened at least 20 cumulative participants during these two visits; we believed that a

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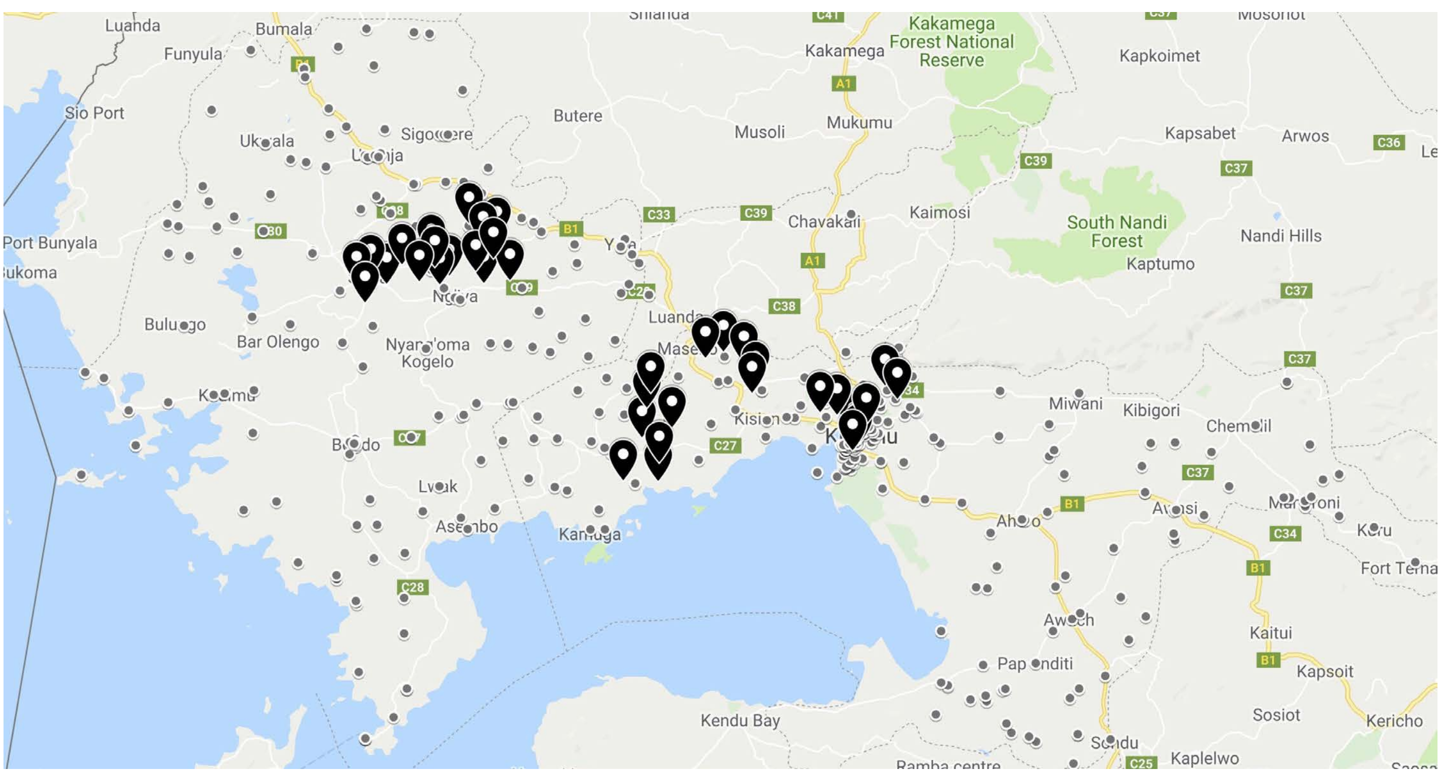

FIGURE 1 Map showing locations of mobile unit sites (teardrops) and health facilities (dots) in Kisumu and Siaya Counties.

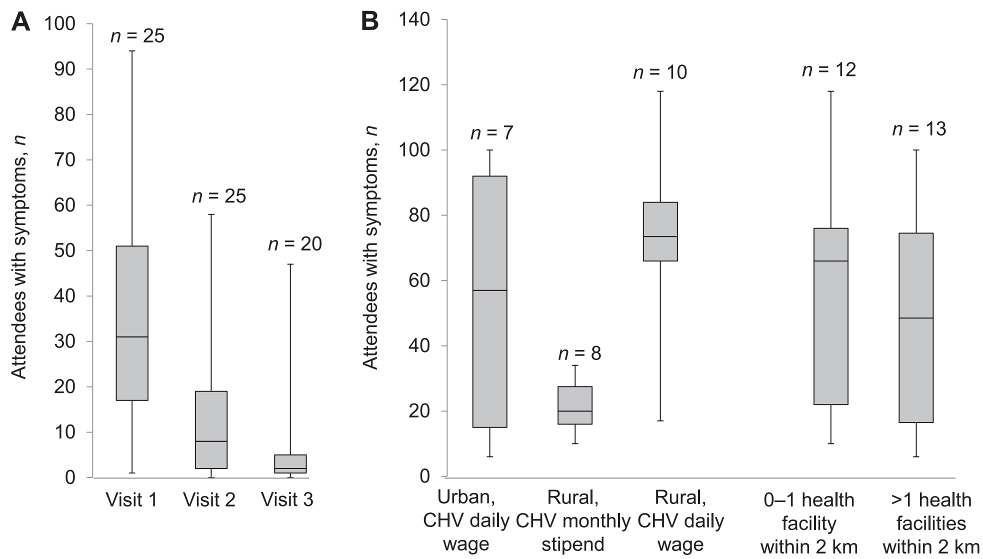

FIGURE 2 Attendance by mobile unit characteristic. Boxes and whiskers represent interquartile range and range. **A)** Attendance each time the mobile unit visited the same site. **B)** Cumulative attendance at mobile unit sites during first two visits, by characteristics of the sites and how CHVs were compensated. CHV = community health volunteer.

yield analysis would not be meaningful if <20 individuals were screened, as a single diagnosis would correspond to a yield difference of >5%. We defined the yield of TB cases as the proportion of adults with symptoms who were diagnosed with TB, and the yield of new HIV diagnoses as the proportion of adults with symptoms who had a positive HIV test result at the mobile unit. We analysed attendance by day of the week and by whether it was the first, second or third time the mobile unit visited a particular site. We analysed both attendance and yield by the payment mechanism for CHVs and the number of health facilities within a radius of 2 km, restricting these analyses to the first and second visits only, as not all sites received a third visit. We used the Wilcoxon rank-sum test for statistical testing; analyses were performed using SAS v9.4 (SAS Institute, Cary, NC, USA).

Ethical considerations

The study was approved by KEMRI Scientific and Ethics Review Unit (SERU; Nairobi, Kenya). The Centers for Disease Control and Prevention relied on the review and oversight of KEMRI SERU. The Walter Reed Army Institute for Research (Silver Spring, MD, USA) determined that the engagement of the US Army Medical Research Directorate-Kenya did not constitute human subjects research. A waiver of consent was granted as the study presented minimal risk to subjects, did not adversely affect their rights or welfare, and because this programme could not feasibly screen the large expected volume of subjects if informed consent were required.

RESULTS

Mobile unit performance

Among the 25 mobile unit sites, seven (28.0%) were in Kisumu City and were considered urban. All seven urban sites, as well as five rural sites 48.0% of the total, had more than one health facility within 2 km of the site; 10 (40.0%) sites had a single health facility within 2 km of the site, and three (12.0%) had no health facilities within 2 km of the site. All seven (28.0%) urban sites and 10 (40.0%) rural sites used CHVs who were paid a daily minimum wage, while eight (32.0%) rural sites employed CHVs who were paid a monthly stipend.

A total of 1424 adults with TB symptoms were screened. The median attendance among individual sites was 54 adults with symptoms (range 6–134, interquartile range [IQR] 24–84). Attendance dropped with each additional visit of the mobile unit to an individual location, with significantly more people screened during the first visit than the second (P = 0.0007) (Figure 2A). Given the variability in attendance across urban sites, the difference between attendance in urban vs. either rural area was not statistically significant (P = 0.1179 and P = 0.3539; Figure 2B). However, mobile units in rural regions where CHVs received a daily minimum wage screened significantly more people than mobile units in rural regions where CHVs were given a nominal monthly stipend (P = 0.0029; Figure 2B). There was no significant difference in attendance based on proximity to health facilities (P = 0.6244; Figure 2B). There was no significant difference in attendance between different working days (Monday through Friday); however, attendance was significantly lower during weekends (Saturday vs. Monday, P = 0.0062; Sunday vs. Monday, P = 0.0118).

At the 25 sites, the median yields of TB diagnoses and new HIV diagnoses out of all individuals screened were respectively 2.4% (range 0.0–16.7, IQR 0.0–5.3) and 2.5% (range 0.0–33.3, IQR 1.2–4.2). The yields of TB and HIV diagnoses among sites with at least 20 screened participants were similar (Tables 1 and 2).

DISCUSSION

We found that attendance at community-based mobile screening units for active TB case-finding was maximised when implemented as a single event in rural areas with CHVs who were paid a daily wage. As the percentage yields of TB and HIV diagnoses were comparable across the mobile unit sites, this suggests that absolute yield was driven by attendance. In rural areas, higher attendance was observed where CHVs were compensated daily for community mobilisation, suggesting that the quality of mobilisa-

TABLE 1 Yield of TB diagnoses among mobile units with at least 20 symptomatic adults screened during first two visits

	Mobile units screening ⩾20 people *n*	Propotion of symptomatic adults diagnosed with TB Median % [IQR] (range)	*P* value
Strategy for recruitment			0.0535*
Urban, CHVs paid daily minimum wage	5	1.8 [0.0–3.0] (0.0–9.3)	
Rural, CHVs given nominal monthly stipend	4	0.0 [0.0–0.0] (0.0–0.0)	
Rural, CHVs paid daily minimum wage	9	1.7 [1.2–2.8] (0.0–6.0)	
Health facilities within 2 km			0.6211†
0–1	10	1.5 [0.0–2.8] (0.0–6.0)	
⩾2	8	0.6 [0.0–2.4] (0.0–9.3)	

* Kruskal-Wallis test comparing the three strategies.
† Wilcoxon rank-sum test comparing the two categories.
TB = tuberculosis; IQR = interquartile range; CHV = community health volunteer.

TABLE 2 Yield of new HIV diagnoses among mobile units with at least 20 symptomatic adults screened during first two visits

	Mobile units screening ⩾20 people *n*	Proportion of symptomatic adults newly diagnosed with HIV Median % [IQR] (range)	*P* value
Strategy for recruitment			0.9371*
Urban, CHVs paid daily minimum wage	5	2.0 [1.5–3.5] (1.1–4.7)	
Rural, CHVs given nominal monthly stipend	4	2.3 [0.0–5.6] (0.0–6.7)	
Rural, CHVs paid daily minimum wage	9	1.9 [1.3–3.0] (1.2–4.9)	
Health facilities within 2 km			0.8610†
0–1	10	2.2 [1.2–3.4] (0.0–6.7)	
⩾2	8	1.9 [1.3–4.1] (0.0–4.9)	

* Kruskal-Wallis test comparing the three strategies.
† Wilcoxon rank-sum test comparing the two categories.
HIV = human immunodeficiency virus; IQR = interquartile range; CHV = community health volunteer.

tion is important for the success of the mobile unit strategy. Attendance was low during the second and third visit of the mobile unit to a given site, suggesting that mobile units need not visit the same location more than once a year. Furthermore, weekend attendance was low, suggesting that TB programs whose staff typically work a standard work week may not have to invest resources in operating weekend mobile units. While these conclusions were drawn from an intervention implemented in a single country, we believe that they are likely generalisable, at least to other sub-Saharan African settings.

Our implementation experiences suggested ways in which community screening efforts could be improved, although we did not collect systematic data on these experiences. As the study team did not supervise CHVs during community mobilisation, it was sometimes challenging to ensure that CHVs carried out mobilisation activities. We received anecdotal reports of residents being hesitant to come to the mobile units because they feared loss of confidentiality, as the CHVs associated with the mobile unit were members of their own communities. Field staff reported that some people who attended the mobile units expected to find more services apart from TB and HIV screening. Finally, while we provided sputum collection containers to participants who were not able to produce spot sputum, few of them brought specimens back to the mobile unit the following morning.

The overall yield of TB cases detected in this intervention was substantially lower than what was observed in the DETECTB study, whose setting and approach were similar to ours.[3] Even so, the fact that many mobile units were well attended even when there were health facilities nearby, suggests that mobile units may play a role in extending the reach of the health system to people who might not otherwise attend a health facility. A recent TB prevalence survey in Kenya found that most people diagnosed with TB during the survey reported that they had not previously sought care at a health facility for their symptoms.[2] Furthermore, the modest yield of new HIV diagnoses that were made suggests that mobile units for combined TB and HIV case-finding might be a worthwhile activity even if the yield of TB diagnoses is low. Finally, our observation that attendees expected more services than just TB and HIV screening suggests that an integrated approach of bringing multiple services into community settings might both serve the population's health care needs better and improve TB case-finding by attracting more people to the mobile units.[10]

We observed low attendance at mobile unit sites where community mobilisation was done by CHVs who were paid a nominal monthly stipend. This may have been because CHVs are better motivated if they are paid a daily minimum wage per day that they work, and because this wage subsidises the transport that CHVs use to cover large areas for community mobilisation. However, because we did not collect information on hours worked by individual CHVs, we could not distinguish between the effects of different payment mechanisms and different numbers of person-hours devoted to community mobilisation (although these two are likely to be related). Nevertheless, other studies have documented challenges related to inadequate CHV compensation. In Uganda, the most common challenge reported by surveyed CHVs was difficulty in reaching clients due to lack of transport, particularly when transport subsidies were insufficient or absent.[11] Similar concerns were raised by CHVs in Swaziland, where CHVs reported spending a large portion of their monthly stipends on transportation for themselves or for getting patients in their care to health facilities.[12]

Our study had several limitations. As we did not collect information on the communities served by each mobile unit site, we could not assess community-based factors that could be useful in choosing mobile unit sites to promote high attendance. In addition, only three of our sites did not have a health facility within 2 km; we were thus unable to rigorously assess the utility of the mobile unit strategy in populations who live very far from health facilities. Furthermore, due to the limited number of sites with high attendance, which would have made the diagnostic yield interpretable, we were unable to identify site characteristics associated with higher yields of TB or HIV diagnoses. Finally, as our intervention was targeted at adults, we cannot generalise our conclusions to children, as screening of children at mobile units may be affected by logistical considerations other than those described here (e.g., children might not be brought on school days).

In conclusion, community-based TB screening can play a key role towards TB and HIV diagnosis among people who do not access health care facilities, and optimising attendance is key for achieving absolute yield. Good community mobilisation by appropriately compensated CHVs was one factor in the successful implementation of community-based mobile screening. We also found that community-based options for care can be useful even when these are set up very near health facilities. To find the cases that are currently missed by health systems and stop the global TB epidemic, strategies for extending the reach of the health system outside health facilities are critical. Community-based TB screening through the use of mobile screening units represents an important strategy to bridge this gap.

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Contexte : Bien que le Kenya soit lourdement affecté par la tuberculose (TB), seulement 46% des cas ont été diagnostiqués en 2016.
Objectif : Identifier les stratégies visant à augmenter la fréquentation des unités mobiles de dépistage en communauté.
Schéma : Nous avons analysé les données opérationnelles d'un essai randomisé en grappes, qui a inclus les unités mobiles de dépistage dans les communautés mises en œuvre entre février 2015 et avril 2016. Les travailleurs de santé communautaire (CHV) ont recruté des individus symptomatiques de la communauté, à qui ont été proposés un test de virus de l'immunodéficience humaine (VIH) et un recueil de crachats pour un test Xpert® MTB/Rif. Nous avons comparé la fréquentation dans les différents sites d'unités mobiles par le test de Wilcoxon rank sum.
Résultats : Au total, 1424 adultes symptomatiques ont été dépistés dans 25 sites d'unités mobiles. La fréquentation médiane totale dans les sites a été de 54 (fourchette : 6–134; intervalle interquartile [IQR]: 24–84). Le rendement médian de diagnostic de TB et de nouveaux diagnostics de VIH a été de 2,4% (fourchette 0,0–16,7 ; IQR 0,0–5,3) et de 2,5% (fourchette 0,0–33,3 ; IQR 1,2–4,2), respectivement. La fréquentation dans les sites urbains a été variable ; la fréquentation dans les sites ruraux où les CHV ont reçu un salaire minimum journalier a été significativement plus élevée que dans les sites ruraux où les CHV ont reçu une compensation mensuelle modeste ($P <$ 0,001).
Conclusion : Les unités mobiles ont été les plus efficaces et rentables quand elles ont été mises en œuvre sous forme d'un évènement unique avec les CHV qui sont payés chaque jour.

Marco de referencia: A pesar de que Kenya tenga una carga de morbilidad por tuberculosis (TB) alta, en el 2016 solo se diagnosticaron 46% de los casos.
Objetivo: Definir estrategias que aumenten la asistencia a las unidades móviles comunitarias de detección sistemática.
Método: Se analizaron los datos operativos de un ensayo clínico aleatorizado en conglomerados, que incluyó unidades móviles comunitarias de detección activa de la TB de febrero del 2015 a abril del 2016. Los agentes de salud comunitarios voluntarios (CHV) incorporaron a las personas sintomáticas de la comunidad, a quienes se ofreció la prueba diagnóstica del virus de la inmunodeficiencia humana (VIH) y el examen de muestras de esputo con la prueba Xpert® MTB/Rif. La asistencia a los diferentes puestos de unidades móviles se comparó mediante la prueba de Wilcoxon para variables independientes.
Resultados: Se examinaron 1424 adultos sintomáticos en 25 puestos de unidades móviles. La mediana de la asistencia global en todos los puestos fue 54 (entre 6 y 134; amplitud intercuartil [IQR] 24–84). La mediana del rendimiento diagnóstico de TB fue 2,4% (entre 0,0 y 16,7; IQR 0,0–5,3) y la de diagnósticos nuevos de infección por el VIH fue 2,5% (entre 0,0 y 33,3; IQR 1,2–4,2). La asistencia a los puestos urbanos fue variable; en los puestos rurales, donde los CHV recibían un salario mínimo diario, la asistencia fue significativamente más alta que en los puestos donde los voluntarios recibían una remuneración nominal mensual ($P < 0{,}001$).
Conclusión: Las unidades móviles fueron más eficaces y eficientes cuando los CHV operaban en un evento único, con remuneración diaria.

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