Costs and Coverage of Community Health Worker-led Hypertension and Diabetes Screening in Rural Lesotho: A Cohort Study with a Cost-Consequence Analysis

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Introduction

Background

Worldwide, non-communicable diseases (NCDs) are responsible for 71% of all deaths, corresponding to 41 million annually.[1] In 2021, arterial hypertension and diabetes mellitus accounted for 10·8 million and 1·6 million deaths, respectively.[2,3] In Southern Africa, NCDs are predicted to overtake communicable, neonatal and maternal diseases as the leading cause of death by 2030.[1] Shortages of healthcare personnel, funding and infrastructure limit the capacity of health systems to tackle the increasing NCD-related chronic care burden.[4]

The involvement of Community Health Workers (CHWs) could be a promising approach to increase access to essential health services.[5] CHWs can be trained and deployed more rapidly and at lower cost than nurses and doctors.[6] Additionally, digital aids like clinical decision support (CDS) tools may enable CHWs to deliver more complex services at better quality and efficiency compared to traditional paper-based systems.[7,8] CHW programmes have already been shown to be (cost-)effective for infectious diseases, reproductive, maternal, neonatal and child health, as well as NCDs such as diabetes and hypertension in various settings.[8–12] However, there remains a paucity of evidence on the real-world costs and reach of combined hypertension and diabetes screening interventions by digitally supported CHWs in resource-constrained settings. To inform budget allocation and priority setting in low- and middle-income countries (LMICs), understanding implementation costs and impact is essential.[13–15]

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In a prospective village cohort, we assessed the coverage rates and costs of a combined hypertension and diabetes screening intervention by CDS-assisted CHWs in Lesotho as a case study to inform similar settings.

Methods

Study design

This is a cost-consequence analysis embedded within a cohort study that evaluates the coverage and costs of combined CHW-led hypertension and diabetes screening in rural Lesotho. The main endpoints were the coverage rates for hypertension and diabetes screening and diagnosis achieved after six months, the cost per person screened and the cost per diagnosis, with further endpoints of interest being the annual intervention cost, and the annual cost per CHW.

Setting

This cost-consequence analysis was conducted within the prospective Community-Based Chronic Care Lesotho (ComBaCaL) cohort study (www.combacal.org/research), which includes inhabitants of 103 randomly selected villages in the rural areas of Butha-Buthe and Mokhothlong districts in Lesotho with the aim to assess community-based, CHW-led chronic care interventions. In each study village one CHW was responsible for service delivery and cohort management. CHWs were selected according to the Lesotho Village Health Programme Policy.[16] The specific criteria are described in detail elsewhere.[17] Once selected, the CHWs underwent a 10-day training on data collection, consent procedures, and recognition of clinical events, followed by two additional 3-day trainings on hypertension and diabetes screening and diagnosis.[7,17] Enrolment, data collection and screening were conducted by CHWs during home visits. The CHWs were supervised remotely by nurses and guided locally by a tailored tablet-based CDS application (ComBaCaL app) providing algorithmic guidance and ensuring adherence to procedures.[7,17,18] By 30th June 2024, a total of 9,243 adult participants were enrolled in the cohort. The study was implemented locally by the not-for-profit organisation SolidarMed, the Ministry of Health of Lesotho and research personnel from the University of Basel, Switzerland. The hypertension and diabetes screening described here were followed by cluster-randomized trials nested within the ComBaCaL cohort study to evaluate the effectiveness of CHW-led care for hypertension and diabetes, which will be reported separately.[17,19,20]

Hypertension and diabetes screening

CHWs started visiting households on 22nd February 2023, and were tasked with enumerating all inhabitants of their villages. This first round of household visits determined the eligibility for the subsequent hypertension and diabetes screening, which happened at the next visit. The screening was followed by community-based treatment and referral as part of cluster-randomized nested trial interventions, which will be reported separately.[19,20]

The diagnostic algorithms followed the Lesotho Standard Treatment Guidelines.[18] Adult participants aged ≥40 years or having a BMI ≥25 kg/m^2 or reporting intake of antidiabetic medication were screened for diabetes using handheld glucometers for capillary blood sugar measurements. Diagnostic criteria included a random blood sugar of ≥11·1 mmol/l or a fasting blood sugar ≥7·0 mmol/l either in presence of cardinal diabetes symptoms (polyuria, polydipsia, and weight loss) or after previously elevated blood sugar (fasting or random blood sugar ≥5·6 mmol/l) on a different day. Participants reporting intake of antidiabetic medication or newly diagnosed according to the diagnostic criteria were considered as having diabetes.

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All adult participants aged ≥18 years were screened for hypertension. At the first visit, the arm with higher systolic blood pressure was identified as reference arm and used for all subsequent measurements. The blood pressure value was calculated as the mean of the last two out of three consecutive measurements at intervals of one minute. For the diagnosis of hypertension, two elevated measurements in the range of 140-179/90-109 mmHg on two different days were required or two measurements of ≥180/110 mmHg on the same day, at least 30 minutes apart. Participants reporting intake of antihypertensive medication or newly diagnosed according to the diagnostic criteria were considered as having hypertension.[17,19,20]

We defined the screening coverage rates for hypertension and diabetes after six months of screening in each of the 103 cohort villages. For each village, we calculated the coverage rate by dividing the number of individuals screened by the number of eligible participants, and then computed the average among all villages. As this is an open cohort with constant documentation of immigration, emigration, deaths, or withdrawals of consent, the number of active participants changes over time. To determine the people eligible for the screening, we only considered participants who were part of the cohort study for at least two months during the six-month observation period.

Duration of the intervention

The start-up phase lasted from 1st October 2022 to 30th January 2023, followed by the running phase from 1st February 2023 to 30th June 2024. The screening was asynchronous in the villages due to stepped training sessions, as well as maternity and sick leaves of CHWs. Overall, there was a three-month gap between the start of hypertension screening in the first and last village and a seven-month gap for diabetes screening. Due to the stepped introduction of hypertension and diabetes screening and the differences in actual screening start dates between villages, the total time required to complete the six months observation period for both diseases across all 103 villages spanned 17 months.

Cost calculation

We conducted the cost analysis adopting a health system perspective and using a combined top-down and bottom-up approach. Predominantly, we employed the top-down method, adhering to the methodological costing checklist developed by Špacírová and colleagues.[21] We identified the cost objects, direct and overhead costs, and specified the cost driver rates for the overhead costs. The bottom-up approach was utilized when resource use could be allocated in detail, specifically for equipment and daily personnel costs during the start-up phase (recruitment and training). We consulted with programme coordinators in Lesotho and Switzerland and relied on the financial records of the implementing organisations SolidarMed and Ministry of Health (MoH) of Lesotho. All expenses were reported in Lesotho Loti (LSL), rounded to the nearest whole number and converted to US$ using the LSL/USD average exchange rate for 2023 as reported by the World Bank (1 LSL=0·05424 US$).[22] We developed two costing models. The project model included research-related expenses specific to this project, while the routine model was designed to reflect the real-world implementation of the intervention in a non-research context from a health system perspective. Detailed differences between the two models are found in table 1. Both models included start-up and running costs. Considering that the project model's running phase lasted 17 months, we applied a 3% discount rate to the costs incurred during the second year.

The start-up phase focused on recruiting and training CHWs and their supervisors. Supervisors received training from academic employees from the University of Basel, while the CHWs were subsequently trained by the supervisors. We calculated the opportunity cost for all individuals participating in the training process based on their salaries. The annual salary cost of a local Ministry

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of Health doctor (LSL925,361 or $50,192) was used as a proxy for the University of Basel personnel's wages. Travel costs for training sessions were covered through monetary reimbursements issued to participants. Upon completing the training, each CHW was equipped with essential equipment and supplies, including a blood pressure monitor, glucometer, weight scale, first aid kit, abdominal measuring tape, consumables, a tablet, backpack, raincoat, and freezer suit. Supervisors were provided with laptops. Intervention research and design costs, as well as expenses related to prior training of personnel before the study enrolment, were not included in our analysis. In the running phase the CHWs carried out the screening. Their activities were supervised and coordinated on a part-time basis by the SolidarMed team, based in two offices.
To determine the cost driver rate for the overheads we compared the ComBaCaL expenses to the overall budget of SolidarMed and found that the former represented 36% of the total cost. We then applied this percentage to the overheads within SolidarMed activities. However, given the differences in staff ratios within the two offices, we adjusted the allocation to 18% of the expenses for both offices.
All CHWs in the project operated within Lesotho's routine health system and received the standard government stipend of LSL800 per month ($43/month). Given the wide variability in CHW salaries across Southern Africa, we conducted a sensitivity analysis to assess how different monthly wages—ranging from $7 to $208 (2019 US dollars), as reported by Masi and colleagues[6]—would affect overall costs. We added the scenario of CHWs working as volunteers as it is a common practice in some settings in Africa.[6] We adjusted the abovementioned stipend range for inflation using Lesotho's consumer price index figures according to the World Bank.[22,23]

Results

Screening coverage

During the observation period, 13,298 individual screening procedures were conducted. At six months, hypertension screening coverage reached 85% (95% CI, 83–87%), with 7,719 out of 9,053 eligible participants screened, and 16% (1,415/9,053) diagnosed with hypertension. Diabetes screening coverage reached 92% (95% CI, 89–94%), with 5,579 out of 6,045 eligible participants screened, and 4% (236/6,045) diagnosed with diabetes (figure 1).

Costs

Including research and protocol-related expenses (project model), the annual intervention costs totalled $451,697. This breaks down to an annual cost of $4,385 per CHW, $331 per diagnosis, and $41 per person screened. In contrast, implementing the intervention in a non-research setting (routine model) would result in annual intervention costs of $315,027, which translates to $3,059 per CHW annually, $136 per diagnosis, and $17 per person screened. A breakdown of the start-up and running costs is presented in tables 2-3 and in the Appendix (tables 1-4).

Sensitivity analysis

In the project model, the cost per participant screened would range from $37 to $64 if CHWs worked as volunteers or received the equivalent of $208, respectively. The annual cost per CHW would be $3,965 and $6,545, respectively. In the routine model, the cost per participant screened would amount to $15 and to $29 if CHWs worked as volunteers or received the equivalent of $208, respectively. The annual cost per CHW would be $2,462 and $6,129, respectively (table 4).

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Discussion

This study evaluated the effectiveness and costs of training and equipping CDS-assisted CHWs to screen for hypertension and diabetes in remote villages of Lesotho. After six months, CHW-led screening achieved coverage rates of 85% for hypertension and 92% for diabetes, at estimated costs of $17 per person screened and $136 per person diagnosed in the routine model.
Existing evidence supports the (cost-)effectiveness of CHW-led interventions in addressing NCDs in LMICs.[8,10,11] However, the extent of healthcare access—measured by the percentage of the eligible population reached—is rarely reported. A study from India reported that digitally-supported CHWs can screen and treat individuals for hypertension and diabetes. However, the authors did not specify the proportion of the population reached through screening, nor did they report costs.[12] In Kenya, a community-based trial described the costs and outcomes of hypertension screening and care. This trial successfully reached 60% of the target population at a cost of $17 per person. While the cost per person screened is similar to ours, the proportion of the target population reached is lower.[9]
While no prior cost data for CHW-led NCD interventions in Lesotho exist, our study aligns with estimates from the region. In Southern Africa, excluding start-up costs, the median annual programme cost per CHW is $2,574 (range: $567–$7,751), while models including start-up expenses report annual costs between $3,610 and $3,750 per CHW.[6,13,25] We incurred annual costs of $4,385 per CHW in the research setting and $3,059 in the routine setting. When excluding start-up costs, these figures decreased to $2,268 and $1,743, respectively. Additionally, we explored scenarios reflecting the predominant compensation models in Southern Africa. In the region, the median monthly salary for CHWs is $35 (ranging from $7 to $208 in 2019 US dollars), yet by 2021, over 3·7 million CHWs across Africa were working as volunteers.[6] In our model, relying on volunteer work would reduce costs by only 10% in the project model and 17% in the routine model compared to the current stipends of 43$ per month. Conversely, compensating CHWs at the highest reported salary of $208 per month increased costs by 53% and 87%, respectively. Inadequate compensation may lead due to subpar work performance and increased costs associated with higher turn-over of CHWs. Thus, determining appropriate compensation and ensuring the required budget allocation tailored to the local economic context, workload, and effectiveness of CHW programmes is key for sustainable success of CHW-led interventions.[26]
Finally, the relevance of CHW programmes can be exemplified by the Lesotho's health system challenges. Despite increased health spending and external funding from 2000 to 2014, Lesotho's health outcomes stagnated or worsened at least partially due to a neglect of primary healthcare system strengthening.[27,28] The 2014 National Health Reform sought to address these challenges through systemic interventions with a focus on HIV, maternal, and child health. Revitalising CHW programmes likely played a key role in improving outcomes in these areas. Expanding CHW roles to include combined hypertension and diabetes screening is a strategic intervention that can strengthen healthcare access and delivery, particularly in countries where a significant portion of the population lives in remote, underserved areas.[27]

Our study has several limitations. First, the budgetary data was collected to track project expenses rather than for specific implementation costing, which may have led to an overestimation of costs due to the challenge of separating individual items within a cost category. Second, the overhead and management cost driver rate (proportion of the ComBaCaL project's costs within SolidarMed's overall budget) introduces some uncertainty, as the expense proportions of different projects within an organisation may not accurately reflect the activity levels required by each project. Third, the full-time equivalent (FTE) estimates for CHWs—76% in the project model and 100% in the routine model—are very generous, as usually CHWs complete a broad range of tasks spanning from for

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infectious diseases to reproductive, maternal neonatal, and child health. Thus, providing hypertension and diabetes screening services as part of an integrated CHW-led care package may significantly reduce costs compared to our results.

In conclusion, our findings demonstrate that a CHW-led CDS-supported hypertension and diabetes screening programme can reach high coverage levels at moderate costs in a remote rural setting in Southern Africa. Moreover, our study provides a valuable economic framework for implementing similar interventions in resource-constrained settings.

Contributors

NS conceptualized the cost analysis and wrote the first draft of the manuscript. FG and NDL supervised the project, provided critical reviews, and edited the manuscript draft. RG and GSS collected and analysed the clinical and costing data, which NS and FG accessed and verified. AC, TT, FR, PS, AA, and PG reviewed and contributed to the manuscript revisions. NDL and AA are the Co-Principal Investigators of the ComBaCaL cohort study and secured the funding. RG and PG oversaw the local implementation of the cohort study. MMat, TK, MMok, MMap, MMol, MK, MMot, SM, MB, MPS, and RK were responsible for the local execution of the intervention and cohort study. LS, MT, and ML coordinated study activities at the Ministry of Health level. All authors had full access to the study data and approved the final manuscript.

Declaration of interests

We declare no competing interests.

Data sharing

The dataset generated and analysed during the current study is available from the corresponding author upon reasonable request.

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Research in Context

Evidence before this study

We conducted a literature search for studies assessing costs and reach of hypertension and diabetes screening interventions by community health workers (CHWs) in low- and middle-income countries (LMICs). On 31st January 2025, we searched Google Scholar and PubMed for articles published since 2007 using the search terms “community health workers,” “screening,” “diabetes,” “hypertension,” “cost,” “low- and middle-income countries,” and “Africa” with no restrictions on study type or language.

We found three studies addressing the (cost-)effectiveness of CHW programmes for hypertension and/or diabetes. In Kenya, a prospective quasi-experimental community-based trial described the costs and outcomes of hypertension screening and care. The intervention reached 60% of the target population at a cost of $17 per person screened. A retrospective cohort study from India examined combined hypertension and diabetes management, reporting that CHWs can feasibly screen and treat individuals for both conditions. However, no cost data was provided. An observational study conducted in Bangladesh, Guatemala, Mexico, and South Africa concluded that hypertension screening by CHWs was feasible and cost-effective, but the study did not specify the screening coverage attained.

Two further publications emphasised the evidence gap in costing data: one literature review highlighted the cost-effectiveness of broader hypertension control interventions but pointed out the lack of costing evidence for CHW-led hypertension programmes in LMICs. Similarly, another systematic review called for more economic evaluations of preventive non-communicable disease programmes to better guide policymakers.

In summary, while some studies demonstrate the effectiveness of CHW-led interventions for single or combined hypertension and diabetes interventions, evidence from larger-scale real-world projects on costs and reach of CHW-led combined hypertension and diabetes screening is not available.

Added value of this study

In 103 remote villages in Lesotho, a landlocked LMIC in southern Africa, CHWs elected among the village population were equipped and trained to conduct hypertension and diabetes screening and diagnosis, assisted by a tablet-based clinical decision support (CDS) application. After six months, CHWs have screened 7,719 participants for hypertension and 5,579 participants for diabetes corresponding to screening coverage rates among all eligible participants of 85% and 92%, respectively. The intervention costs from a health system perspective were $3,059 per CHW annually, $136 per person diagnosed, and $17 per person screened.

Implications of all the available evidence

CHWs who are appropriately trained, equipped, and assisted by a CDS application can successfully screen for hypertension and diabetes and achieve high coverage rates in remote, underserved populations. The costs are comparable to other, already established CHW interventions in Southern Africa. These findings support the integration of hypertension and diabetes screening and diagnosis into CHW programmes and non-communicable disease policies in resource-constrained settings.

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Tables

References are reported in the manuscript.

	Project model	Routine model
Start-up phase	Recruitment of CHWs	No recruitment (pre-existing network of CHWs)
Start-up phase	Project training (including research- specific training)	Proportion of training dedicated specifically to service delivery (screening and diagnosis) (0·5)
Start-up phase	Project supervision: Salaries of 4 nurses, 4 nursing assistants, 1 data officer and 2 coordinators (including research-specific supervision)	Proportion of supervision: Salaries of 2 nurses, 2 nursing assistants, 1 data officer and 1 coordinator(excluding research-specific supervision)
Overheads	Salary of project manager (Swiss salary)	Salary of coordinator (local salary)
Overheads	Salary of project accountant	10% overhead on personnel salaries
Running phase	Cohort enrolment/enumeration	No cohort enrolment/enumeration
Running phase	76% of CHW working time for 17 months	100% of CHW working time for 6 months

Table 1. Differences between the costing models.
The project model includes research-related costs (e.g. questionnaires and blood tests for endpoint collection of cluster-randomized trials following the screening and diagnosis). The 76% figure represents the weighted average of the days CHWs spent on screening activities over a 17-month period.
The routine model only accounts for the resources needed to implement the screening in a real-world routine setting. Training costs were adjusted to reflect the smaller clinical team and then multiplied by 0·5 (proportion of training concerning screening and IT practicalities). Furthermore, CHWs are assumed to start the screening simultaneously in all villages and not be delayed by maternity, sickness, and deferred training sessions. In view of this, they are expected to dedicate 100% of their working time for six months. The proportion of screening-specific training and the routine equivalent of the project manager were determined through interviews with programme coordinators, and with regards to the existing healthcare infrastructure in Lesotho. The 10% overheads for administrative services and the downsizing of the clinical team were based on discussions with study personnel and literature.[24] CHW: Community health worker.

Category	Item	Cost (Project model)	Cost (Routine model)
Recruitment and training			
	CHWs recruitment	$19,877	-
	Supervisor and CHW training	$75,486	$29,234
Equipment			
	Medical devices	$41,418	$41,418
	IT Hardware and accessories	$61,365	$56,538
Management			
	Project manager salary	$11,804	$2,145
	Project accountant salary	$2,002	NA
	Data and IT officer salary	$2,801	$2,801
Overhead costs			
	Offices (rent, bills, clerk)	$3,353	$3,353
Total		**$218,106**	**$135,489**

Table 2. Start-up costs.
All variable expenses reported encompass four months as the start-up phase spanned from 1st October 2022 to 30th January 2023. Recruitment and personnel training include personnel, accommodation, and transport costs. Medical equipment includes consumables (examination gloves, sharp containers, alcohol swabs etc) and durable items (blood pressure measurement instruments, glucometer, weight scale, drug box, abdominal tape etc). Non-medical equipment includes tablets for CHWs, laptops for the supervisors, accessories (tablet covers, screen protectors) and attire for field work (raincoats, backpacks, and freezer suits). All expenses were rounded to the nearest whole number and converted to US$ using the LSL/USD average exchange rate for 2023 as reported by the World Bank (1 LSL=0.05424 US$).[22] CHW: Community health worker.

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Category	Item	Cost -Project Model	Cost-Routine model
Healthcare personnel			
	CHWs	$40,761	$53,633
	Supervisors	$87,027	$43,514
Equipment			
	Medical consumables	$13,276	$13,276
	IT hardware maintenance	$3,840	$3,840
	Data and airtime	$21,902	$21,902
Management			
	Project manager	$35,411	NA
	Local Coordinator	NA	$6,436
	Project accountant	$6,007	NA
	Data and IT officer	$5,394	$5,394
	Administrative services	NA	$11,570
Overhead costs			
	Offices (rent, bills, clerk)	$10,059	$10,059
Other costs			
	On-site supervision of CHWs	$9,913	$9,913
Total		$233,590	$179,537

Table 3. Yearly running costs.
The project accountant was not factored in the routine model and instead a 10% on personnel salaries was added to cover for administrative services. Accordingly, the project manager would be replaced in a routine setting by a local coordinator. On-site supervision of CHWs includes personnel and transport cost of supervisors to support CHWs when issues arose. All expenses were rounded to the nearest whole number and converted to US$ using the LSL/USD average exchange rate for 2023 as reported by the World Bank (1 LSL=0.05424 US$).[22] CHW: Community health worker.

CHW monthly stipend	Cost per CHW (Project model)	Cost per CHW (Routine model)	Cost per person screened (Project model)	Cost per person screened (Routine model)
$0	$3,965	$2,462	$37	$15
$9	$4,052	$2,585	$38	$15
$43	**$4,385**	**$3,059**	**$41**	**$17**
$45	$4,400	$3,079	$41	$17
$267	$6,545	$6,129	$64	$29

Table 4. Sensitivity Analysis: The impact of varying CHW stipend inputs on costs.
The median monthly salary for CHWs in Southern Africa is $35 (range: $7–$208) in 2019 US dollars. These values were adjusted for inflation to 2023 and used as the basis for our analysis, alongside the $43/month stipend provided in our study, which is presented in bold as the reference value. A stipend of $0 reflects the scenario of CHWs working as volunteers (see main text). All expenses were rounded to the nearest whole number and converted to US$ using the LSL/USD average exchange rate for 2023 as reported by the World Bank (1 LSL=0.05424 US$).[22] CHW: Community health worker.

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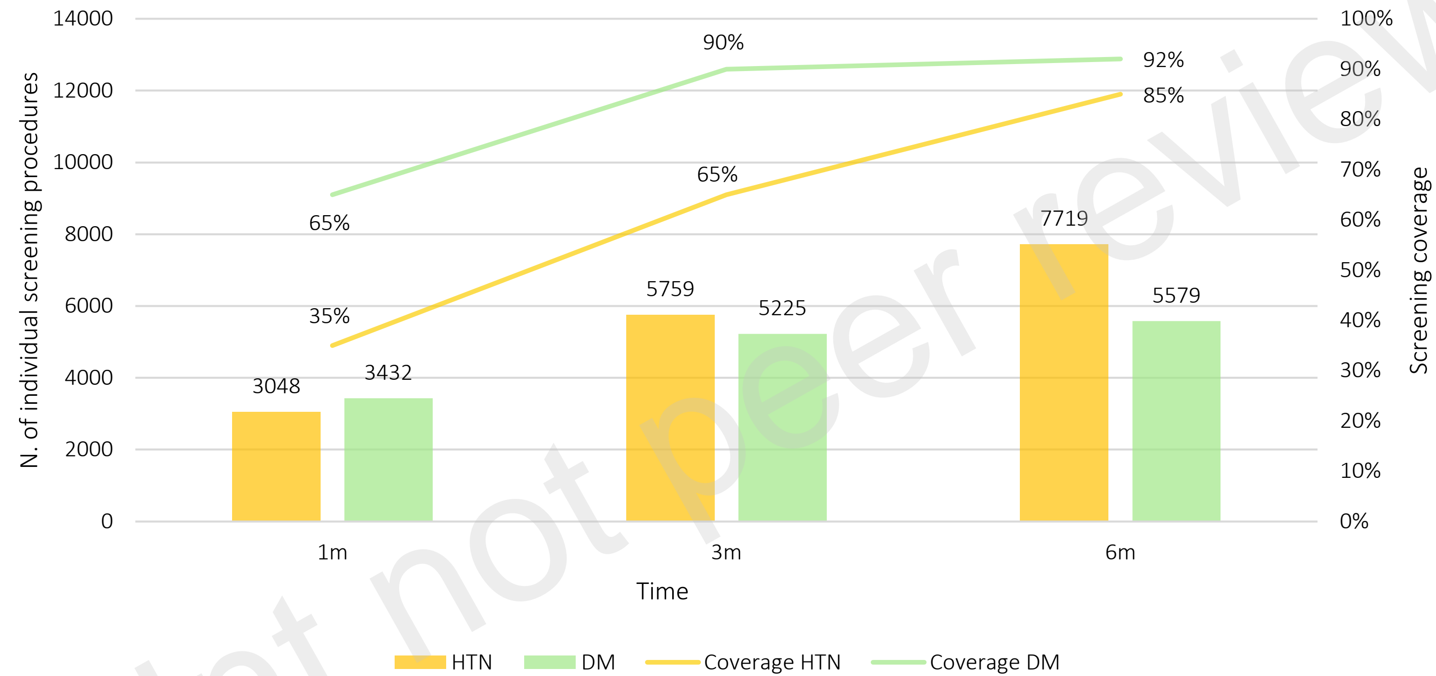

Figure 1. Cumulative number of screening procedures for diabetes and hypertension, along with disease coverage rates. These are calculated as the average of the rates achieved in each village. HTN: hypertension. DM: diabetes mellitus.

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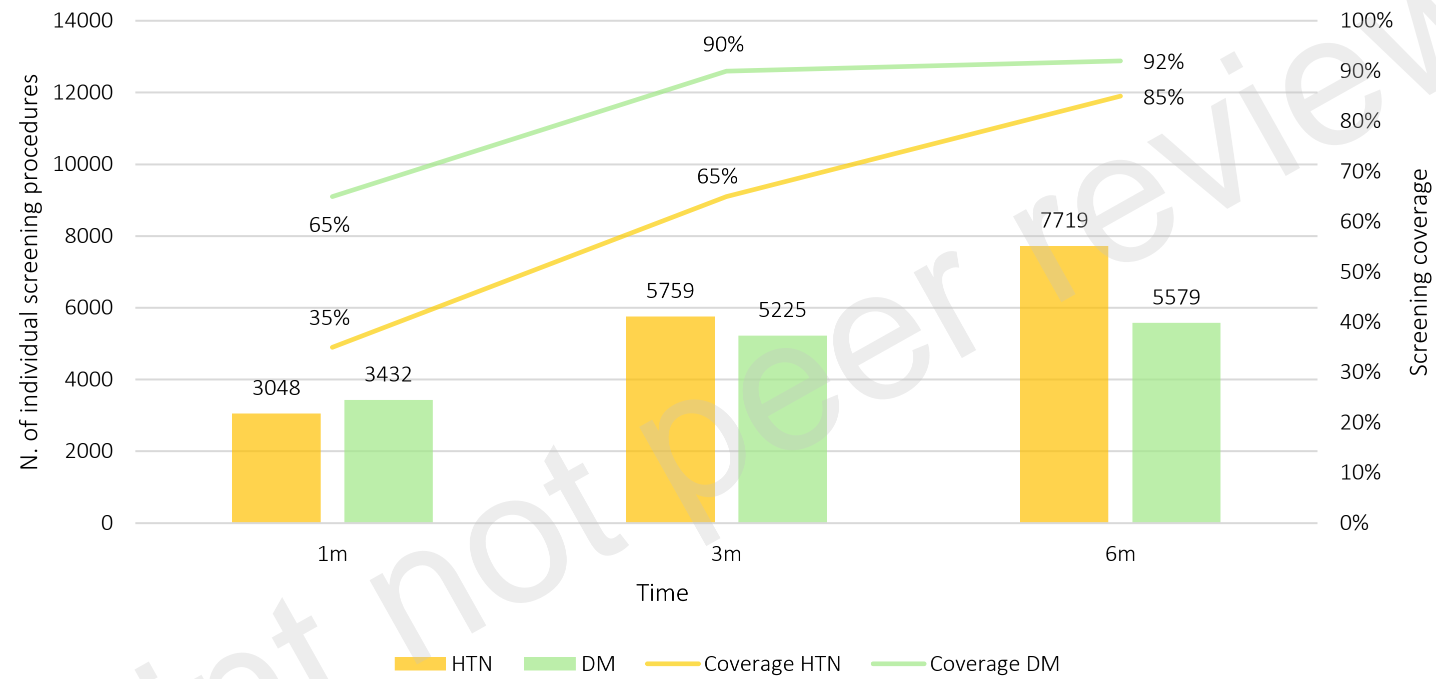

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