Cardiovascular disease prevention in the slums of Kenya
van de Vijver, Steven

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: http://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.
CHAPTER 10

Implementation, outcomes, and associated costs of a community-based intervention for primary prevention of cardiovascular disease in an urban slum in Kenya

Samuel Oti, Steven van de Vijver, Gabriela Gomez, Charles Agyemang, Mildred Adhiambo, Thaddaeus Egondi, Catherine Kyobutungi, Alex Ezeh, Karien Stronks

Bulletin of the World Health Organization, submitted
ABSTRACT

Background
About 80% of global deaths due to cardiovascular diseases (CVD) occur in low and middle income countries (LMICs) such as Kenya. Hypertension is the leading risk factor for CVD and there is evidence that its prevalence is on the rise in urban poor settlements across LMICs. This paper aims to describe a multi-component community-based intervention, SCALE UP, aiming to reduce CVD risk through awareness campaigns, improvement in the access to screening, and standardized clinical management of hypertension among adults aged 35 years and older in a large slum in Nairobi.

Methods
The SCALE UP intervention comprised various components each addressing a specific step in the care cascade from screening to treatment, retention in care, and control of hypertension. We describe the implementation process and outcomes of each intervention component, using multiple sources of data including administrative databases and representative surveys. We also estimated the costs associated with the intervention using a top-down costing approach and presented in US$2013 per unit outcome.

Results
The SCALE UP project reached 60% of the target population (4,049 people at US$17 per person screened), provided access to treatment for 68% of persons referred (660 people US$123 per person with hypertension who attended the clinic), retained in care 27% of those recruited to the clinics (178 patients at US$207 per person who attended six or more visits), and achieved blood pressure control among 33% of those retained in care (n=58/178). The total intervention cost per patient with blood pressure controlled was US$3,224.

Conclusions
Although it was possible within reasonable costs to achieve awareness and treatment levels comparable to high-income settings, these results show that retention in care and blood pressure control remain a challenge in these settings. Patient-related costs and accessibility are key barriers to retention in care that require public health intervention.

Trial registration
Current controlled trials ISRCTN84424579
INTRODUCTION

Cardiovascular diseases (CVD) –primarily strokes and ischemic heart disease– are the leading cause of death globally [1, 2]. They account for approximately 17 million deaths each year, and are expected to rise to 23 million by 2030 [3]. The main drivers of the global CVD epidemic are urbanization and industrialization, which lead to an increase in the adoption of sedentary lifestyles, unhealthy dietary patterns [4], tobacco consumption, and alcohol misuse [4]. Recent burden of disease estimates show that about 80% of deaths due to CVD worldwide occur in low- and middle-income countries (LMICs) such as Kenya [2]. This disproportionate distribution is attributable to a multiplicity of factors including low awareness of CVD risk at individual- and population-level and limited access to quality and affordable preventive and curative health care, especially at primary level.

Hypertension is the number one risk factor for CVD, and its prevalence is increasing worldwide –from over 25% in 2000 to a projected 40% in 2025 [5]. In Kenya, the mean systolic blood pressure for adults has increased from 127 to 132 mmHg between 1990 and 2010, while in high-income countries such as U.S and The Netherlands there have been declines in mean SBP of up to 3 mmHg over the same period [6]. The burden of hypertension is amplified by very low levels of awareness, treatment, and control of hypertension, particularly among urban poor populations in LMICs [7]. On one hand, recent findings in such settings suggest that when people are made aware of having hypertension, they tend to seek care [7, 8]. On the other, the level of adherence to treatment for hypertension remains dismally low for a variety or reasons including, but not limited to, high costs of treatment, low perceived risk of CVD, and deference to traditional medicine which is believed to offer one-time cure rather than lifelong treatment [9-14].

The vulnerability of urban poor populations to high levels of uncontrolled risk factors for CVD such as hypertension is of significant concern to public health practitioners. This is largely be-
cause the continual population growth in urban poor settlements or slums across the LMICs is placing a significant burden on the already overstretched health systems, while at the same time accounting for a lack of improvement or deterioration in urban health indicators [15, 16]. UN-HABITAT reports that approximately 60% of the Kenyan population resides in slums or slum-like conditions [17]. Slums are typically characterized by poor living conditions, psychosocial stress, and lack of access to basic social amenities including primary health care.

In response to evidence of a growing burden of risk factors for CVD in slum populations in Kenya, a community-based intervention was developed and implemented from August 2012 to December 2013. Full details of the evaluation of this project are described elsewhere [18]. In brief, the SCALE UP intervention was multi-component and prioritized 7,500 adults aged 35 years and above in a large slum in Nairobi with the overall aim of reducing CVD risk through awareness campaigns, improvement in the access to screening, and standardized clinical management of hypertension. This paper aims to describe the implementation and process evaluation of the SCALE UP intervention.

METHODS

Context
Korogocho slum, located on the eastern part of Nairobi, is home to about 35,000 people resident across seven villages. Within this slum, two primary health clinics were invited to participate—a private non-profit and a community-owned primary health center. Both clinics were well-known in the slum. Although most patients made out-of-pocket payments for services received, the clinics offered services at highly subsidized prices (through donor funding). Nurses and clinical officers (health personnel with a diploma in clinical medicine) provided all consultations.
**Intervention**

The SCALE UP intervention was developed based on a theoretical modelling exercise published elsewhere [19]. In summary, we sought to determine theoretically the most cost-effective combination of all possible iterations of activities that could address each step cascade in the continuum of preventive care for CVD, with a focus on hypertension management. The final selected package of activities that constitutes the SCALE UP intervention is shown in Figure 1. This intervention was implemented for 17 months from August 2012. Full description of the intervention can be found elsewhere [18]. Briefly, the intervention was divided into three components:

1. **Raising awareness and improving access to screening**
   Community health workers (CHWs) were recruited and trained to conduct door-to-door household visits in order to raise awareness about CVD risk, conduct screening, and provide brief counselling assistance among all consenting adults aged 35 years and above in Korogocho. Anthropometric and clinical measurements including height, weight, waist and hip circumference, blood pressure,

![Figure 1: SCALE UP package of interventions](image)

Adapted from Oti et al 2013 [18]
and fasting blood glucose were measured. Community sensitization about the household visits was conducted via local radio campaigns, community meetings, and religious gatherings.

2. *Facilitating access to quality treatment*

All persons with elevated blood pressure (≥140 mmHg systolic and/or ≥90 mmHg diastolic) were referred to any of the two participating clinics. Free treatment was available to all referred persons who visited the clinics for the first time for their first visit (valued at about US$1.80) as an incentive to encourage patients to seek care for hypertension. All subsequent treatment (medication) at the clinic was, however, to be paid for by the patients. Additionally, CHWs received an incentive of US$3.0 per appropriately referred patient who visited the health facility, to motivate the CHWs to follow-up each patient.

3. *Promoting long-term retention in care*

Patients were then organized into support groups by village. Each support group received an incentive: a group reduction in the price of medication by one-third (approximately US$0.6) if they collectively achieved 80% or more attendance to follow-up visits for a consecutive period of six months. Patients were also to nominate support group representatives to be trained by clinicians as peer-educators with an in-depth knowledge of CVD prevention, care, and etiology. Financial incentives were also offered to CHWs to organize the support groups (US$1.8 per support group participant attending the CVD clinics for at least six consecutive months as scheduled). Finally, we sent SMS reminders to patients monthly reminding them of scheduled clinic appointments.

**Analysis**

**Conceptual framework**

The conceptual framework we followed for the data collection and analysis is in respectively Table 1 and the additional file 1 (both below the paper). First, we listed the inputs needed to implement activities such as trainings or attendance of religious services by
CHWs. These activities resulted in a number of outputs, such as number of CHWs trained. The outputs led then to outcomes, i.e. number of people aware of their hypertension status. Overall, all outcomes ultimately should result in an impact —blood pressure control.

Data sources
The main sources of administrative data were activity reports, minutes of meetings, training attendance records, official emails, and other relevant records. However, we supplemented these data with data sourced from population- and clinic-level surveys conducted at baseline and at the end of the intervention period. Detailed description of the methods and results of these surveys are provided elsewhere (Impact evaluation of a community-based intervention for prevention of cardiovascular diseases through screening and treatment of hypertension in the slums of Nairobi: the SCALE UP study. van de Vijver S et al, unpublished).

Additionally, we sought to identify the possible explanations for the outcomes observed in each step of the continuum of care cascade. For screening and awareness, we used field reports to document the reasons why not every prioritized adult was reached by the intervention. For treatment seeking and retention in care, we conducted semi-structured interviews with a random sub-sample (n=188) of referred patients who defaulted from scheduled visits or never attended the clinics.

Finally, using anonymized routine medical records from the two intervention clinics, we present the levels of blood pressure control achieved among patients during the intervention. We present both the proportion of all patients retained in care (defined as patients with six or more clinic visits within a 12 month period) whose blood pressure is controlled to below 140/90 mmHg as well as the mean change in blood pressure among these patients. To understand the factors associated with blood pressure control, we conducted a logistic regression where the main outcome was blood pressure control status (yes/no), and explanatory variables including age, sex, body mass index (BMI), drug side effects, and
Morisky score as a proxy for adherence to medication regimen [20, 21].

Costs
Costs were estimated from a provider perspective in US$ (2013). We included all service and above service level costs for each itemized activity per intervention component for the duration of the intervention (17 months starting from August 2012), and excluded evaluation and research-related activities. These costs were excluded as they are not a part of service delivery. We used a top-down costing approach allocating out costs to intervention components, then to activities by input type (see additional file 2). This was done through the review of financial records (for which we had comprehensive access), time sheets, and interviews with staff. Part of management staff costs were first allocated out proportionally to time spent on other projects. This was ascertained through interviews. SCALE UP staff costs were then allocated to implementation activities based on the relative duration of research and implementation activities. For all costs, we first allocated those costs that could be clearly tracked to a particular component. For those remaining shared costs, we allocated across components based on the level of effort in hours dedicated to the activities in each component. We accounted for additional costs such as security escorts for our staff due to the field conditions. However, we excluded treatment costs for those assaulted. We report economic costs including items for which there were no financial transactions, for example rental of clinic space (these were valued using market prices). Capital costs were annualized using a discount rate of 3%.

The total costs for all inputs by itemized activities within each intervention component were then added up to get the total amount spent on that component. We then divided the total cost per component by the quantifiable unit of outcome per component—resulting in the cost per unit of outcome per intervention component. Finally, we added the total cost of all components and divided that by the number of people with blood pressure under control to get the cost per unit of impact.
Ethical Considerations

The SCALE UP study was approved by the Kenya Medical Research Institute/National Ethical Review Committee (NON-SSC Protocol No. 339). All participants gave written informed consent both at door-to-door screening and at the clinics.

RESULTS

Implementation

We recruited a total of 50 CHWs resident in Korogocho slum to undergo one week training. The training contents, which were developed by the study team, covered basic information about CVD risk factors and their manifestation, theory and practical sessions on anthropometric and clinical (blood pressure and blood glucose) measurements, as well as brief counseling assistance (BCA). We evaluated the knowledge of training participants through a comparison of pre- and post-training test results on CVD and associated risk factors. The average pre-test score was 25 percentage points. Following the average score rose to 80 percentage points – only one CHW scored below 50 percentage points in the post-test and did not continue in the project.

During the first three weeks (mid-July – early August 2012) of the intervention, CHWs participated in a total of seven community meetings (one per village) and 21 religious meetings (three per village) where they sensitized the community about the planned household screening and awareness campaign. Concurrently, a radio jingle developed by the study team was aired for three weeks on the local radio station – Korogocho FM. After this introductory period, the CHWs conducted household visits for five months. Visits were scheduled using a list of all adults aged 35 years and older according to the Nairobi Urban Health and Demographic Surveillance System (NUHDSS) database as at 15 June 2012. The NUHDSS has been operated by the African Population and Health Research Center (APHRC) since 2002 and details of its operations have been published elsewhere [22]. After a maximum
of three unsuccessful attempts, the adult was considered as “not reached”.

Alongside, the study team set up two CVD clinics at existing primary health facilities. This involved: 1) negotiating for a space to attend to patients; 2) installing a tent on the provided space; 3) providing basic diagnostic equipment; and 4) recruiting and training two nurses and clinical officers on how to manage uncomplicated hypertension using standardized guidelines developed by the study team based on international clinical guidance [23].

CVD clinics ran every Tuesday and Thursday from 8am to 4pm. The nurses took routine clinical measurements while the clinical officers offered patient consultation and dispensed medication. Medication for hypertension was purchased by the study team and distributed to the CVD clinics. The medication purchased included generic thiazide diuretics, angiotensin-converting enzyme inhibitors, calcium channel blocker and oral hypoglycaemics. These were dispensed to patients in monthly cycles. Equipment supplied to the clinics include: digital blood pressure monitors, glucometers, digital weighing scales, portable stadiometers and measuring tapes.

CHWs kept registers of every person they screened and those who were referred to the clinics. Each referred person was given a paper voucher granting them access to a free first time treatment at either of the two CVD clinics. The CHWs were asked to follow up on those patients referred who did not attend the clinic, and if available and consented, to administer a brief semi-structured interview to identify their reasons for non-attendance. At the clinics, a medical records clerk was employed and equipped with a computer Netbook pre-loaded with electronic medical record forms designed and programmed by the study team. Paper-based versions of the medical records forms were completed by nurses and clinical officers for each patient and then transferred into the electronic version by the clerk. Finally, to promote retention in care, SMS reminders were sent monthly to each referred patient and CHWs organized referred patients into support groups. These support groups met once a month.
**Process evaluation**

Awareness and screening

CHWs successfully screened and counselled 4,049 out of 6,780 (60%) of the target population (see figure 2). Reasons for not reaching the remaining 40% of the target population are presented in figure 3. Main reasons include persons not being found (n=719, 10%), their whereabouts were unknown (n=252, 4%), and out-migrated or exited slum (n=281, 4%). Only 164 (2%) refused to participate in the study. Out of the 4,048 people screened, 976 people with raised blood pressure were identified and referred.

**Figure 2:** Outcome indicators on each step in the cascade of CVD care

**Figure 3:** Reasons for not being screened in first wave as a percentage of total population eligible for screening (n=6,780)
Out of the 976 persons referred to the clinics, 845 (87%) attended the CVD clinic at least once. Of these, 185 were found to have normal blood pressure levels after confirmatory measurement by the nurses. A total of 660 patients out of 976 referred (68%) started on treatment at CVD clinics (see Figure 2). Out of 131 persons who were referred to the clinic but did not attend, 61 (47%) persons answered the exit interview; the leading reported reasons for non-attendance (Figure 4) were lack of time (n=17, 28%), cost of treatment (n=14, 23%), and forgot clinic appointment (n=9, 15%).

Figure 4. Reasons for not attending clinic or dropping out of clinic (n=188)

Retention in care
By the end of the intervention period, a total of 4,519 SMSs had been sent and seven support groups had been formed with a total of 371 persons attending the meetings at least once. The average number of support group meetings attended by each person was 3.5 over the entire intervention period.

Figure 2 shows that a total of 178 out of 660 patients (27%) attending the CVD clinic were retained in care (defined as having 6 or more visits over a 12 month period). Out of those not retained in care (n=482), the CHWs followed up 127 (26%) in their homes. Figure 4 also shows the main reasons for not being retained in care included cost of treatment (n=45, 35%), lack of time (n=26, 21%) and forgot clinic appointment (n=22, 17%).

Impact
Figure 2 shows that 58 out of 178 (33%) patients retained in care had their blood pressure controlled by the 6th visit. This amounted to approximately 9% (58/660) of all patients recruited into the clinics. The mean systolic blood pressure of those retained in care was 161.6 mmHg at the first visit. This was reduced by 12.3% (19.8 mmHg reduction) by the 6th visit. The mean diastolic blood pressure of those retained in care reduced by 10.3% from 100.5 mmHg at the first visit to 90 mmHg by the 6th visit.

Adherence to medication (measured through the Morisky score) was found to be significantly associated (adjusted OR 0.66, 95% CI 0.45–0.98, p=0.037) with having blood pressure controlled by the 6th visit (controlling for age, sex, BMI, and having any self-reported drug side effect).
**Impact**

Figure 2 shows that 58 out of 178 (33%) patients retained in care had their blood pressure controlled by the 6th visit. This amount to approximately 9% (58/660) of all patients recruited into the clinics. The mean systolic blood pressure of those retained in care was 161.6mmHg at the first visit. This was reduced by 12.3% (19.8 mmHg reduction) by the 6th visit. The mean diastolic blood pressure of those retained in care reduced by 10.3% from 100.5mmHg at the first visit to 90mmHg by the 6th visit. Adherence to medication (measured through the Morisky score) was found to be significantly associated (adjusted OR 0.66, 95% 0.45-0.98, p=0.037) with having blood pressure controlled by the 6th visit (controlling for age, sex, BMI, and having any self-reported drug side effect).

**Costs per patient with blood pressure controlled**

Table 2 shows the summary of the unit cost per intervention component. The unit cost per person reached via screening and awareness was US$22. For access to treatment, the cost was estimated at US$33 per person seeking treatment. It cost US$36 per person to retain a patient in care. The overall cost of getting a person screened, treated, retained in care, and finally have their blood pressure under control is US$2,008.

**DISCUSSION**

In summary, the SCALE UP intervention reached 60% of the target population, provided access to treatment to 68% of eligible patients with hypertension, retained 27% in care, and achieved blood pressure control among 33% of patients retained in care or 6% of all those detected with high blood pressure in the population. These results show that the “rule of halves” is still valid in this population especially with regards to retention in care and BP control. The “rule of halves” states that ‘half of hypertensive patients are known to health services (i.e. remain undiagnosed), half of those with known hypertension do receive any treatment, and
half of those who are treated, do achieve adequate control [24]. Several studies in developing countries have shown that indeed the levels of awareness treatment and control of hypertension as still quite dismal, with control rates ranging from 4% to 47% among patients aged 35–49 years old [25]. And even worldwide, only 13% of people with hypertension have it adequately controlled [26]. Our study showed that with a comprehensive community-based intervention it is possible to achieve awareness and treatment rates above the 50% cut-off mark. Achieving awareness and access to treatment levels that are comparable to developed countries is a great accomplishment especially in unstable populations such as the slum context where annual migration rates alone could get up to 30% [27]. However, retention in care and control rates in our population remains sub-optimal despite the intervention components designed to address them.

One such intervention components was an incentive system tailored to the prioritized population with the hope of motivating access to treatment and retention in care. Using financial incentives or lowering financial barriers to influence health behavior is a well-established strategy, though often with mixed results [28]. Our incentive system comprised the subsidization of anti-hypertensive medication at our CVD clinics to cost only US$1.80 per patient per month (does not include consultant and lab costs which are typically provided for free in public health facilities in Kenya).

This is less expensive than the open market where the same medication would typically cost around US$10. We were able to subsidize the cost of medication significantly by purchasing them in bulk from a medical supplies agency that served non-profit organizations. Importantly, the typical individual daily earnings in the slum setting in Kenya is approximately $3, so the price was set to be equivalent to forfeiting less than one days’ earning for a full month supply of medication. We however found that our incentives were not strong enough to keep majority of patients retained in care. Yet, we believe this finding is setting-specific: over 90% of slum residents have out-of-pocket expenditures for health [29] and more than 50% report being food insecure [30]. More-
over, majority of those who defaulted from the clinic cited cost as a main reason. In other words, although treatment costs were subsidized, it was still a barrier to care. Cost is not an issue in slum setting alone. In a 2010 study in 36 mostly LMICs, cost was analysed for a group of antihypertensive drugs that included one from each of the five major classes [31]. The study found that one month of daily treatment with one hypertensive drug cost on average 1.8 days’ wages, and many patients will need more than one drug to achieve control. The WHO has set a global target of a 25% reduction in the prevalence of hypertension by 2025 [32]. If this target is to be achieved, then mechanisms must be found to make drugs more affordable, as has occurred with drugs for the treatment of HIV/AIDS and tuberculosis.

Aside from costs, other reasons identified for dropping out of care seem more amenable to future intervention. For example, it is understandable that people who rely on daily scouting for informal jobs would be too pre-occupied during weekdays to attend a clinic. This could explain why those who defaulted from the clinics cited not having time as the second most important reason for not dropping out. We believe that tailoring clinic opening hours to meet this need (e.g. on weekends) might be a better strategy going forward. Also, we found that not remembering clinic appointments was an important reason given by defaulters for not being retained in care. It appears that our use of SMS reminders were not effective. This is not surprising as use of SMS has shown mixed results in other disease domains such as HIV, TB and Malaria [33-35]. Further research will be needed to understand how to overcome this barrier.

In terms of the cost of our intention, we found the cost of the entire SCALE UP intervention per person with BP controlled to be US$3,224.4. This is comparable to other public health interventions in the Kenyan setting. For example, the implementation of option B+, in which HIV-positive pregnant women are started immediately on ART and continued for life – a comparable intervention as it includes screening, diagnosis, and chronic treatment – was recently estimated to be US$6,015 per infection averted [36].
When we place the cost of each component of the SCALE UP intervention in the context of other public health interventions we also find equivalencies. For example, the economic evaluation of a multifaceted intervention to improve the quality of care of children in district hospitals in Kenya found the cost per child admission to be US$50.74 – comparable to our unit cost of US$122.8 per person seeking treatment [37].

We acknowledge several limitations in our study: 1) due to budgetary limitations we were unable to collect all the data we had intended to collect (e.g. fasting blood glucose for all study participants) in order to determine the ten-year CVD risk; 2) in terms of logistics, we faced certain constraints to working in a slum setting. For example, we had a few cases of violent crime (robberies and assault) against our CHWs which led to additional study costs – providing security escorts and treatment costs for those assaulted. There was also the attempted interference with our study by local politicians. Fortunately, this was overcome by our efforts at community mobilization and engagement which fostered ownership in the study and sustained it to the end. It is important for anyone who intends to conduct research in the slum settings to be cognizant of these challenges.

In conclusion, the SCALE UP intervention achieved reasonable success in terms of raising awareness and treatment levels in a challenging resource-constrained setting at a costs that in principle would be regarded as affordable. However, the intervention underperformed in terms of addressing levels of retention in care and blood pressure control. We recommend that further research, especially operational research, be conducted to address retention in care and blood pressure control in such settings. It would be particularly useful to contextualize the recently launched Global Standardized Hypertension Treatment (GSHT) approach in resource constrained settings across LMICs where the burden of hypertension and CVD in general appears to be on the rise. The GSHT Project, launched in 2013 by the US Centers for Disease Control and Prevention, in collaboration with the Pan American Health Organization (PAHO), aims to create a framework for treatment
of hypertension that is sufficiently flexible for worldwide use [38].
The GSHT approach promotes care delivery elements that can be integrated into all health-care systems. These include patient registries, standardized treatment guidelines, patient-centered care, community involvement, and the use of multidisciplinary teams to facilitate redistribution of specific clinical tasks across the care delivery team (that is, task sharing).

Overall, we view the implementation of the SCALE UP intervention and the outcomes as highly encouraging and we hope our findings will stimulate further research and interventions on hypertension and CVD risk reduction in often marginalized communities.

Acknowledgements
We would like to thank all the participants and community health workers that made this intervention possible. We also would like to acknowledge the following people and organizations for their support in this study: the staff of APHRC for their support through drivers, field interviewers, research assistants and statisticians. We also acknowledge the following staff and affiliated researchers of AIGHD for their practical and scientific support in the course of the project: Eric P Moll van Charante, Lizzy M Brewster, Marleen E Hendriks, Constance Schultsz, Zlata Tanovic and Frank van Leth. Finally, we dedicate this paper to the memory of the principal investigator of the SCALE UP project -- Prof Joep M.A Lange who tragically passed away before the manuscript was completed.

Conflict of interest
None declared.

Funding sources
The SCALE UP Study was funded by the Academic Medical Center (AMC) Foundation, Amsterdam, The Netherlands. This work was also made possible by core funding for APHRC from The William and Flora Hewlett Foundation (grant no. 2009-40510), the Swedish International Cooperation Agency (SIDA) (grant no. 2011-001578), and the Rockefeller Foundation (grant no. 2009SCG302). The funders were not involved in the study design, data collection or analysis, or in the writing or submitting process of this article.
Authors’ contributions
SO and SV both conceptualized the study. SO, SV, GBG, CA, MA, TE, MH, CA, AE and KS all participated in the study design and implementation as well as contributed to the writing of the study protocol, drafting and editing of this manuscript. All authors read and approved the final manuscript.
REFERENCES

<table>
<thead>
<tr>
<th>Component</th>
<th>Inputs</th>
<th>Activities</th>
<th>Outputs</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness and screening</td>
<td>Banners, PA system, Facilitators (Community leaders, expert patients)</td>
<td>Number of baraazas held</td>
<td>Number of people that attended baraaza</td>
<td>Proportion of target population screened and aware of their blood pressure</td>
</tr>
<tr>
<td>Religious services</td>
<td>Facilitators (CHW, religious leaders)</td>
<td>Number of religious services attended by CHWs</td>
<td>Number of people that attended religious services</td>
<td>Proportion of all patients retained in care (defined as patients with 6 or more clinic visits within a 12 month period whose BP is controlled to below 140/90 mmHg as well as the mean change in blood pressure among these patients.</td>
</tr>
<tr>
<td>Radio jingle</td>
<td>Julie content developer, Local radio station (Koch FM)</td>
<td>Frequency and duration of airplay of jingles</td>
<td>Estimated listenership</td>
<td></td>
</tr>
<tr>
<td>CHWs</td>
<td>Facilitators (Medical/Research Officers, Training facilities, Allowances)</td>
<td>Number of trainings that took place</td>
<td>Number of CHWs trained</td>
<td></td>
</tr>
<tr>
<td>Door-to-door screening</td>
<td>CHW allowances, screening equipment and materials</td>
<td>Number of CHWs conducting screening</td>
<td>Number of people screened</td>
<td></td>
</tr>
<tr>
<td>Referral</td>
<td>Peer educators, Supervisor confirmation</td>
<td>Number of CHWs conducting referral</td>
<td>Number of people referred</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Facilitators (Medical/Research Officers, Training facilities, Allowances)</td>
<td>Number of trainings that were held</td>
<td>Number of clinic staff trained</td>
<td>Proportion of referred persons recruited into clinic</td>
</tr>
<tr>
<td>Standard treatment guidelines</td>
<td>Meetings and review by stakeholders</td>
<td>Number of meetings held</td>
<td>Guideline document published</td>
<td></td>
</tr>
<tr>
<td>Upgrading and equipping of clinics</td>
<td>Construction of consultation area, equipment</td>
<td>Number of consultation areas constructed, number of equipment supplied</td>
<td>Number of clinics upgraded and equipped</td>
<td></td>
</tr>
<tr>
<td>Management of referred patients at clinics</td>
<td>Clinic staff allowances, utilities and supplies (including medication)</td>
<td>Number and frequency of clinic sessions held</td>
<td>Number of first-time patients attending clinics</td>
<td></td>
</tr>
<tr>
<td>Intervention component</td>
<td>Total cost ($) per component</td>
<td>Outcome (number of persons reached at each stage)</td>
<td>Cost ($) per person reached</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------------------------</td>
<td>--------------------------------------------------</td>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td>Awareness and screening</td>
<td>69,224.7</td>
<td>4,049</td>
<td>17.1</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>81,018.6</td>
<td>660</td>
<td>122.8</td>
<td></td>
</tr>
<tr>
<td>Retention in care</td>
<td>36,770.4</td>
<td>178</td>
<td>206.6</td>
<td></td>
</tr>
<tr>
<td>BP control</td>
<td>187,013.7</td>
<td>58</td>
<td>3,224.4</td>
<td></td>
</tr>
</tbody>
</table>
**ADDITIONAL FILES:**

Additional file 1 – Detailed process evaluation framework results

<table>
<thead>
<tr>
<th>Component</th>
<th>Inputs</th>
<th>Activities</th>
<th>Outputs</th>
<th>Outcomes</th>
<th>Main Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness and screening</td>
<td>Baraza</td>
<td>Baraza, PA system, Facilitators (Community leaders, expert patients)</td>
<td>7 baraazas held</td>
<td>Estimated at between 50 and 80 people attended</td>
<td></td>
</tr>
<tr>
<td>Religious services</td>
<td>Facilitation (CHWs, religious leaders)</td>
<td>21 religious meetings held</td>
<td></td>
<td>Estimated at between 30 and 50 people attended</td>
<td></td>
</tr>
<tr>
<td>Radio jingle</td>
<td>Jingle content developer, Local radio station (Koch FM)</td>
<td>1 jingle lasting 50 seconds aired 3 times daily for 3 weeks</td>
<td>Koch FM listenership estimated at 250,000 people</td>
<td>60% (4049 screened out of 6780 residents aged 35 years and older)</td>
<td></td>
</tr>
<tr>
<td>CHWs</td>
<td>Facilitation (Medical/Research Officers), Training facilities, Allowances</td>
<td>1 training + 1 refresher training held</td>
<td></td>
<td>*50 CHWs trained</td>
<td></td>
</tr>
<tr>
<td>Door-to-door screening</td>
<td>CHW allowances, screening equipment and materials</td>
<td>39 CHWs conducted door to door screening</td>
<td></td>
<td>4049 people screened</td>
<td></td>
</tr>
<tr>
<td>Referral</td>
<td>Free vouchers, Supervisor confirmation</td>
<td>39 CHWs conducted referrals</td>
<td></td>
<td>976 people referred</td>
<td></td>
</tr>
</tbody>
</table>
### Treatment

<table>
<thead>
<tr>
<th>Clinic staff</th>
<th>Facilitators (Medical/Research Officers), Training facilities, Allowances</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 training + 1 refresher training held</td>
<td>2 nurses, 2 clinical officers and 1 medical records clerk trained</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard treatment guidelines</th>
<th>Meetings and review by stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 main meeting held with stakeholders. Guideline reviewed mostly by email correspondence</td>
<td>1 guideline document published</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Upgrading and equipping of clinics</th>
<th>Construction of consultation area, equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 clinics upgraded. Concrete floor constructed and tent erected in 1 clinic. Both clinics received 2 sets of screening equipment and light furniture for the consulting areas</td>
<td>2 clinics upgraded</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Management of referred patients at clinics</th>
<th>Clinic staff allowances, utilities and supplies (including medication)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinics held twice a week for 17 months</td>
<td>845 attended clinic first time, of which 660 were eligible for recruitment into care</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Retention in care</th>
<th>Follow up of defaulters</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHW allowances (including incentives and resources)</td>
<td>188 defaulters followed up and interviewed by CHWs</td>
</tr>
<tr>
<td>SMS reminders</td>
<td>4519 SMS sent</td>
</tr>
<tr>
<td>Both SMS application</td>
<td>46 defaulter returned to clinic after follow up</td>
</tr>
<tr>
<td>660 patients received SMSs</td>
<td>27% (178 retained in care out of 640 that were recruited into treatment)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Support groups</th>
<th>CHW, facilitators, incentives</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 support groups formed. 28 support groups held</td>
<td>371 people attended support groups</td>
</tr>
</tbody>
</table>

*Although 50 CHWs were trained, not all were deployed to conduct screening. Some dropped out of the study and others were deployed to assist with managing the clinics.*
### Additional file 2 – Costs considered in each input category

<table>
<thead>
<tr>
<th>INPUT</th>
<th>Costs considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>Salaries of all categories of staff and consultants</td>
</tr>
<tr>
<td>Commodities and supplies</td>
<td>Costs of drugs, tests consummables and all training and communication materials</td>
</tr>
<tr>
<td>Training</td>
<td>Costs of space, travel, food and accommodation for participants - excluding staff costs</td>
</tr>
<tr>
<td>Capital cost</td>
<td>Equipment, furniture, building (tents, floors and labour to set up)</td>
</tr>
<tr>
<td>Building operating and maintenance</td>
<td>Communication, security, cleaning, and repairs</td>
</tr>
<tr>
<td>Transport</td>
<td>Mileage allowance for supervision visits</td>
</tr>
<tr>
<td>Intervention activities</td>
<td>All payments for incentives to CHWs and patients, SMS, community mobilisation and adherence support</td>
</tr>
<tr>
<td>Indirect expenses</td>
<td>Reported overhead expenses</td>
</tr>
</tbody>
</table>