



## RESEARCH ARTICLE

**REVISED** *“We shall have gone to a higher standard”*: Training village health teams (VHTs) to use a smartphone-guided intervention to link older Ugandans with hypertension and diabetes to care [version 2; peer review: 2 approved]

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### Abstract

**Background:** It is not clear whether village health teams (VHTs) can be empowered to participate in interventions to prevent and control hypertension and diabetes in older adults in Uganda. We conducted this study in rural Uganda to establish if VHTs could be effectively trained to use a smart phone guided intervention to link older people with hypertension and diabetes to care. We also explored the experiences of VHTs in managing older adults with health problems, their knowledge of hypertension and diabetes and their understanding of referral systems. We also explored their experiences with smartphones.

**Methods:** We conducted in-depth interviews (IDIs) with and trained 20 VHTs randomly selected from Bukulula sub-county in Kalungu district from October 2017-December 2018. We used interview guides to explore topics relevant to our study objectives. VHTs were trained to measure blood sugar and blood pressure using digital machines. VHTs were trained on identifying symptoms of diabetes mellitus. Data from IDIs were analysed using thematic content analysis. Competence tests were used to evaluate the training.

**Results:** Most of the VHTs were female (75%). All VHTs had some knowledge on hypertension and diabetes and other chronic diseases. They did not have any experience in treating older adults since they had been trained to deal mainly with children. Half of the VHTs owned smartphones. All were willing to participate in an intervention using a smartphone to link older adults with hypertension and diabetes mellitus to care. By the end of the training, all but three participants could comprehend the symptoms of diabetes and measure blood sugar and blood pressure.

**Conclusion:** Village health teams in the study setting need training in

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managing the health needs of older adults before engaging with an intervention using smartphones to link older adults with diabetes mellitus and hypertension to care.

### Keywords

ageing, non-communicable diseases, community health workers, Uganda

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**REVISED Amendments from Version 1**

In the abstract, we rephrased the main objective of the study to relate to the study title. We thus stated the main objective of the study to state that “we conducted this study in rural Uganda to establish if VHTs could be effectively trained to use a smart phone guided intervention to link older people with hypertension and diabetes to care”.

In the introduction, we added four more references to citing work of other researchers on training lay persons to recognise chronic diseases and refer people identified with these diseases to care. Studies done elsewhere have shown that trained lay persons including community health workers can successfully be taught to measure and recognise chronic diseases and refer people identified with chronic diseases for care

Under the methods, we have introduced a new section about VHTs, in Uganda, how they are selected and their roles. I cited 4 references under this subsection. Under study population, we have rewritten this sub section to give more details on how we selected our study sample. Under the section of training VHTs, we have added more details on cuff sizes and how to find an average of the blood pressure measurements. In the discussion, we added some sentences on our findings in the results section about VHTs not having previous experiences in handling older people with chronic problems.

**Any further responses from the reviewers can be found at the end of the article**

**Introduction**

The number of older adults living with chronic conditions is increasing rapidly in Uganda<sup>1-4</sup>. These chronic conditions include hypertension, diabetes mellitus, chronic obstructive pulmonary disease, cardiovascular diseases, osteoarthritis and cancer. Evidence available suggests that most of these older people with chronic conditions either do not know that they have them<sup>3,5,6</sup>, or may not be on treatment<sup>7</sup>.

Recently, greater attention has been paid to interventions for the prevention and control of chronic conditions in public health care<sup>8-10</sup>. However, in sub-Saharan Africa these interventions do not usually focus on older people, who are disproportionately affected by chronic conditions<sup>11</sup>. Studies conducted in Uganda and elsewhere in Africa have shown that older adults have delayed access to health care due to a number of reasons<sup>12-14</sup>. These may include personal factors like poor health, lack of resources and, for chronic diseases, awareness of disease symptoms. Others may include factors related to the health care facilities, including responsiveness of the health care staff to older people and availability of the drugs.

With the increasing numbers of older adults with chronic conditions, especially hypertension and diabetes mellitus, there is a need for public health interventions that will improve referral of older adults with chronic conditions from within their communities to formal health care facilities for proper diagnosis and treatment. One of the possible public health interventions that could be used is to strengthen the capacity of VHTs to screen older adults in their communities for some of the more prevalent

chronic conditions like hypertension and diabetes. Once screened, those suspected to have chronic conditions can be referred to health care facilities for full diagnosis and treatment.

Village health teams (VHTs) are community health workers in Uganda. The concept of these VHTs was introduced in Uganda by the Ministry of Health to promote health services, including referral of people to formal health care facilities<sup>15</sup>. The VHTs are selected by their communities, who agree on who they want to represent them. The VHTs are supposed to work on a voluntary basis, although a small facilitation payment is given depending on the intervention. Some of the responsibilities of the VHTs include mobilising the communities for health action, promoting health and preventing diseases, treating simple illnesses at home, checking for danger signs at home, referring sick people to health workers and keeping up-to-date village records<sup>15-17</sup>.

The VHTs are at the lowest end (village level) of the Ugandan health care system, which starts with the Ministry of Health, national referral hospitals, regional referral hospitals, district hospitals, health centres at level four (constituency level), health centres at level 3 (sub-county level), health centres at level 2 (parish level) and then VHTs<sup>18</sup>.

There are some advantages of involving VHTs in the control and prevention of chronic conditions in Uganda. First, VHTs are already part of the primary health care system in Uganda and have been involved in a number of interventions, especially in maternal and child health. Second, the health care system in Uganda is understaffed and VHTs could play a role in the screening of older adults with chronic conditions. In addition, VHTs work on a voluntary basis and thus few resources are needed for the VHTs to be involved in the prevention and control of chronic conditions. Studies done elsewhere have shown that trained lay persons including community health workers can successfully be taught to measure and recognise chronic diseases and refer people identified with chronic diseases for care<sup>19-22</sup>. The use of smartphones in rehabilitation, linking of patients to care and management of patients is now increasing<sup>23-27</sup>. In Uganda, it has been shown that community health workers can use smartphones to register pregnant women at home and relay gestation age-specific SMS messages to them to reduce home births<sup>28</sup>. A study in Uganda looking at the experiences of using mobile phones in everyday life among people who had suffered a stroke and their families established that mobile phones can play a key role in the rehabilitation of patients<sup>29-31</sup>.

In preparation for developing a smartphone-guided intervention to strengthen the capacity of VHTs to screen and refer older adults with hypertension and diabetes to care, we conducted this preliminary study among VHT members from Kalungu district in rural southwest Uganda to establish the experiences of VHTs in dealing with older people with hypertension and diabetes mellitus, their experiences with smartphones and to establish whether VHTs were willing and could be effectively trained to use a future planned smartphone-guided intervention to link older Ugandans with hypertension and diabetes mellitus to care.

## Methods

### Ethical statement

The Uganda Virus Research Institute Research and Ethics Committee (GC/127/18/01/630) and the Uganda National Council for Science and Technology approved this study (SS4530). Before the interviews, a study information sheet was administered to all study participants and all those that agreed to participate signed a consent form. In addition, permission to audio record the interviews was sought from all the VHT members that were interviewed.

### VHTs in Uganda

A Village Health Team (VHT) are people chosen by their own community to promote the health and wellbeing of all village members<sup>16,32-34</sup>. To qualify as a VHT, one has to have completed senior four/ ordinary level education. This concept is implemented in Uganda by the Ministry of Health to ensure that every village has the capacity to mobilize individuals and households for better health. In all villages in Uganda, the VHT role is carrying out general tasks in all Primary Health care (PHC) core activities that include: home visiting, mobilization of communities for utilization of health care services, health promotion and health education, management of common illnesses, follow up of pregnant mothers and new borns, follow up of discharged patients and those on long term treatment and community information management. Once the VHT has been selected they are trained on a number of topics that include: interpersonal communication, community mobilization and empowerment, child growth and development, control of communicable diseases, sexual and reproductive health, environmental health mental health and monitoring record keeping. VHT are recruited as volunteers and are expected to carry out their activities without any monthly salary<sup>34</sup>.

### Study setting

This study was conducted in Bukulula sub-county, Kalungu district in rural southwest Uganda between October 2017 and December 2018. According to figures from the Uganda Bureau of statistics, the population of Kalungu district was approximately 350,000 in 2017 and 5% of this population were aged 60 years and above<sup>35</sup>. Bukulula is the second most populous sub-county in the district and lies along the highway that connects Kampala to Tanzania, Rwanda and the Democratic Republic of Congo. The population of Bukulula sub-county depend on agriculture and migrant labour for their livelihoods but some communities around the shores of Lake Victoria depend on fishing. Within Kalungu district, 41% of the females aged 10 years and above own mobile phones, compared to 44.8% of the males aged 10 years and above. The proportion of the population with smartphones is not known. The district has two level 4 health centres, with one of these health centres located at Bukulula sub-county headquarters. There are a number of other public and private health facilities within the district that cater for both communicable and non-communicable diseases.

### Study design

The study was done in two phases. The methodological orientation we used in phase one of this study was content analysis. In

phase 1, we used qualitative research methods to collect data from the selected VHT members. During the second phase, we conducted training sessions with all the 20 VHT members that had participated in phase one. During the training, we used short presentations, discussions and practical exercises that involved all the selected VHT members.

### Study population

We selected 20 members of the VHTs from within Bukulula sub-county. Since this was a preliminary study in preparation of a bigger study in future, a sample size of 20VHT members would be able to provide us with enough qualitative information that we needed to answer our research question. These were randomly selected from all the VHTs in the sub-county. Bukulula Sub County comprises of 69 villages. Each village has two VHTs in accordance with the Uganda Ministry of health guidelines<sup>16</sup>. Thus, the total number of VHTs in this sub county were 138. To select the 20 from 138, a raffle method was used. Names of all the 138 villages were written on small pieces of paper (one paper for each village). These were put in the box and churned. The district VHTs coordinator would pick a paper and then churning would be done again. This process was repeated until 20 papers were picked. Twenty VHTs from the villages that were picked were selected to participate in the study. All the VHTs within the sub county fulfilled the inclusion criteria. The inclusion criteria were; that the VHT had to be a resident of Bukulula sub-county and should have been active in the VHTs work within the sub-county in the last 3 months. VHTs were excluded if they were not in position to participate in the interviews and were not willing to attend the training. The selection of the VHTs was done in consultation with stakeholders within the sub-county and the district including the coordinator of the VHTs within the district. Out of the twenty originally selected, two were replaced because they declined to participate. They declined participation because they were working from far away in Kampala (capital city of Uganda) and did not have time to come back to Bukulula to participate in the interviews.

### In-depth interviews (IDIs)

Before IDIs were conducted, all the selected VHT members were invited for a meeting (through a phone call made by the District VHT Coordinator), which was co-chaired by the principal investigator (PI) and the district VHT coordinator. This meeting was conducted at Bukulula Health Centre Level 4. During the meeting, we explained all study procedures to the selected VHT members and a schedule for the interviews was made and agreed to by all the selected VHT members.

The IDIs were conducted by the PI (JOM) together with a female social science research assistant. The research assistant completed high school but later trained as a social science research assistant and has been working as a social sciences research assistant with MRC/UVRI and LSHTM Uganda Research Unit for a period of 25 years. Interviews were conducted in English (for VHTs who were comfortable with English) and in Luganda, the local language used in the study setting (for those who preferred Luganda). The interview duration was 45 minutes to

one hour. All interviews were conducted in a quiet room at Bukulula Health Centre in the morning. The interviews followed an interview guide that explored the following: demographic characteristics; VHT recruitment; training and activities of the VHTs; experiences in dealing with older people; linking of people with health issues to care; knowledge of common chronic diseases; experiences and perception of smartphones; and willingness to use a smartphone-guided intervention in the future to link older people with chronic conditions to care. All interviews were audio-recorded and field notes made.

### Training of VHTs

The VHTs underwent three-day non-residential training. The training was basic given the level of education of the VHT members (very few had completed ordinary level at senior school, despite Uganda Ministry of Health recommendations that VHT members should be educated to this level). The training sessions were conducted by the PI (JOM), the district VHT coordinator and a qualified nurse. During the training, the following topics were covered: ageing in Uganda and some common diseases associated with ageing; introduction to hypertension and diabetes mellitus; identifying simple symptoms and signs of hypertension and diabetes mellitus; complications of hypertension and diabetes mellitus; the referral process from villages to formal health care facilities and what should be included on referral forms. VHT members were also taught how to draw blood and test for blood sugar using a portable glucometer (ONETOUCH SelectSimple blood glucose meter)<sup>36</sup>, and how to measure blood pressure using a digital blood pressure machine (OMRON, Automatic Upper Arm Blood Pressure Monitor M7 Intelli IT (HEM-7322T-E))<sup>37</sup>. In addition, the VHTs were trained on identifying the appropriate cuff size, and how to prepare study participants for blood pressure measurement. The VHTs were also taken through an exercise of calculating the average BP measurement from the 3 measurements that were undertaken for each individual. In addition, practical exercises for measuring blood sugar and measuring blood pressure were conducted during the training sessions. A qualified nurse, working with MRC/UVRI and LSHTM Uganda Research Unit and the District VHT Coordinator, who is a qualified clinical officer, conducted the practical sessions. The practical sessions were supervised by the PI (JOM), who is a qualified medical doctor with a long-term experience in managing older people with chronic conditions in Uganda. Each VHT member drew blood from a colleague and tested the blood sugar level. Likewise, each VHT member took at least three blood pressure measurements from a colleague and recorded the blood pressure measurements. All the practical exercises were conducted in the sub-county hall at Bukulula sub-county headquarters near Bukulula Health Centre Level 4.

### Data management and analysis

Transcription and translation (for interviews conducted in Luganda) of the interviews was undertaken by two social science research assistants within two days after the interviews. After the first two interviews were transcribed and translated, the PI and the social science research assistant involved in the data collection read the scripts to check for completeness of data collection. After the first two interviews, the interview guide was slightly revised. The modifications that were made after the

two interviews were introducing a question to capture data on the challenges faced by VHTs while doing their work. When all the interviews were completed and after reading through all the interview scripts and exploring the emerging themes, the PI and the social science research assistant agreed on a coding framework that was used to code all the data. To code the data, we used a matrix with the main themes that arose from the data including nomination procedures for becoming VHT, period of service as VHT, challenges faced by VHTs, definition of an older person, definition of chronic conditions, dealing with older people with chronic conditions, experiences with smart phones, ownership of smart phones, acceptability of using smart phones in a future intervention and problems likely to arise with use of smart phones. Data were analysed by thematic content analysis.

For training, competence tests were used to evaluate the practical exercises. Competency scores were given for all steps of the practical exercises. For practical exercises, one point was awarded for each step done correctly. The final score was calculated in percentages. Tests for blood pressure measurement and blood sugar measurement were scored separately. For blood sugar measurement, these steps included:

1. Preparing the person for the blood draw
2. Wearing gloves correctly
3. Inserting the strip in the glucometer correctly
4. Identifying and cleaning the finger for the blood draw
5. The procedure of drawing blood
6. Reading the glucometer correctly
7. Removing the gloves correctly
8. Proper disposal of sharps and other materials
9. Recording an accurate reading from the glucometer
10. Final advice given to the client in accordance with the level of the blood sugar

For blood pressure measurement, competency scores were given for the following steps:

1. Preparing the person for blood pressure measurement
2. Using the right blood pressure cuff
3. The procedure of measuring the blood pressure
4. Accurate recording of the blood pressure measured
5. Advice given to client after blood pressure measurement

If a VHT member scored 80% and above for these steps, we considered them to have passed the competence test.

## Results

### Demographic characteristics of study population

In total, we performed IDIs with 20 VHTs. Most of the VHT members were female, 16 (80%), and married, 16 (80%), and only six (30%) had completed ordinary level in secondary school (locally known as senior 4). The sample included four (20%) VHT members who were aged 60 years and over. The majority of these VHT members were mainly small-scale farmers, 15 (75%), and had been serving as VHT members for five years and over, 15 (75%).

After obtaining demographic information from the study participants, we went on to establish their experiences in dealing with older adults.

### Experiences in dealing with older adults with health issues

We first asked the participants how they defined an older person or how they knew a person was old. Most of the study participants defined ageing according to physical appearance and rate of work.

*You understand that someone is aged depending on how she/he appears because you may find someone and notice she has become weak/reduced strengths and when you look into the face, you realise she is aged. She could be having grey hair, you can realise she is weak in what she is doing, has reduced strengths and when you merely look in her face, she is aged. (40–50-year-old female VHT, primary school education).*

When this same participant was asked about age, she replied with the following:

*In most cases, majority [referring to older adults] do not tell their age/true age yet others do not happen to know. However, if you happen to have followed age, personally I can start from 50 years onwards. That person happens to be old.*

When another respondent was asked how you know that someone was an older person, she said:

*She would be starting from the age of 60 years, then you can know that she is old and okay, another condition is bending of the back, when she ages, she has signs she shows. She moves with the support of the stick. Some cannot support themselves. Sincerely, the work she used to do at the young age, she cannot manage at the moment (30–40-year-old female VHT, secondary school education)*

When another participant was asked whom he considers an older person to be, he said:

*He would have been...Ha...you see I am also an elderly. Let us say ageing comes about or takes place at every stage. You might be 50 but then you become old; or when you fall and the back becomes affected and you are like this.... [He demonstrated moving with his back curved]. Or when you get an accident and you no longer have any work to do (60–70-year-old male VHT secondary school education)*

None of the VHT members had experience in treating old people with health problems. It was noted that when the concept of VHTs was introduced in Kalungu district, they were selected and trained to only deal with children between two and five years who had fever and diarrhoea. At some point, other maternal and child health programmes were added to their responsibilities. However, some VHTs assist in supervising people with chronic conditions like tuberculosis (TB) who are referred to them from formal health care facilities for supervision in taking their medications properly.

*I also see some elderlies [older people] because I usually treat some elderlies who have TB. They usually refer them to me, those men who are found with TB; they smoke cigarettes and tobacco so much. I have still treated them and at times, they go to health centres (40–50-year-old female VHT, secondary education).*

This same VHT member went on to say that she also helps monitor adherence for patients on TB treatment:

*You happen to be there and they phone you [phone call from health centre], VHT such and such a patient does not swallow/take tablets well. There is even a health worker who came just looking for him, he got him and then handed him [patient] to me. My dear God blessed me, whenever he used to bring the tablets they [health workers] would tell him, take them to the lady [VHT member]. He had stopped taking the tablets for about a year and then they started him on the drugs afresh. I then started administering it to him.*

### Knowledge of chronic conditions

All the VHT members were able to define and mention some of the chronic conditions that were common in their communities. Some of the diseases mentioned included hypertension, diabetes, asthma, HIV/AIDS, diseases of the heart, cancer, prostate cancer, persistent cough, stomach ulcers, swelling of the whole body, and possession of cholesterol. However, their understanding of the impact of these diseases for an individual, their family and the community was mixed. While all of them understood the impact of the chronic diseases to an individual, half of them did not understand the impact of chronic diseases on the family and at the community level.

When one VHT was asked to mention some of the chronic diseases that affect older people, he said

*I can understand like the HIV, say like these illnesses...what are they called? HIV, I have talked about it; the chronic diseases, sometimes you might...only that even diabetes we count it among them. You might fall sick with Asthma, you can fall sick with; what do they call it? Someone being that he experiences swelling of his body. They have these illnesses those that somehow old; experience frequent urination; within that old age. It is to say that when a man or a woman, has to pad himself/herself. Yes, such illnesses (30–40-year-old male, secondary education).*

When asked about chronic diseases that affect older people, another VHT said

*Those sicknesses, backache, legs (meaning painful legs), pressure/hypertension, diabetes; all diseases collect when one becomes old; poor eye sight, mist like substances within the eyes; things of that kind/such diseases (60–70-year-old male, secondary education).*

### Experiences of VHT members with smartphones

All VHT members had seen and some owned smartphones. A big proportion (70%) of the VHTs did not know a local name for the smart phones but others gave local names including *koloboza* (putting a finger and scrolling), *kuseereza* (scrolling),

*kukoona* (to hit), *songa* (starting), and *kibaati* (made of iron). These are local names in the Luganda language. Most of these words refer to how smart phones are used by placing a finger on the screen of the smart phone.

VHT members reported the functions of smart phones as: making and receiving calls, Facebook, WhatsApp, Twitter, taking and sending messages, taking and sending photographs, making processes quicker, enabling owners to become dignified (being held in high esteem within the community because of using smart phones), recording voices, having access to voicemails, taking records/documents and knowing what is happening in the international world easily by connecting to the internet.

When we asked them if they knew of any government programme using smartphones, three participants mentioned the Coffee Development Authority (CDA) programme that gave smartphones to some selected farmers in their communities and that these farmers were sending information to the secretariat of the CDA. However, they did not know the type of information that was being sent. Another participant talked of a small-scale loan organisation called BRAC.

All the VHT members were interested in the use of the phones and said they would accept using a smartphone-guided intervention to link older people with chronic conditions to care.

*“We shall be more than happy to use these phones to send old patients to health centres. We shall feel good. We shall have gone to a higher standard. And it becomes easy for us because I happen to be referring a patient quickly and easily....”* (60–70-year-old male, secondary school education).

*“I shall be very pleased to use those phones [smartphones]. I shall be very pleased health worker [referring to interviewer] because I had earlier longed to use that phone before but not able to buy it. However, longing for it when you happen to give it to me free of charge, I can become very happy to use it in that program you talked about of older people”* (40–50-year-old female, completed primary 7)

Although most of the VHT members were willing and happy to use smartphones to link older people with chronic conditions to care, they expressed a number of challenges they would face while using these smartphones, including the need for rigorous training to learn how to use them, theft of smartphones and failure to find somewhere to charge the phone (since the reach of the electricity supply in the area is limited).

*“It would be when I have not yet learnt to use I [smartphone]. You can give it to me doctor but when I do not know how to use it. That is one problem/challenge. Another problem it has these [smartphones] are very much liked by the kyala kimpadde [thugs]. Then in case it does not have power, I do not have electricity at my home; I have to take it where....at the shop so that they do what....they might steal it from there. That is a big challenge reporting to my boss that they have stolen the phone from me!”*

*At times he might not have trust in me, can say you are lying, you sold it. Now that problem is there when it happens to have used up power. It is a big problem* (40–50-year-old female, secondary education).

### Practical exercises

All VHT members said the practical exercises were very exciting and expressed their wish that it would be good if they could have these frequently during their routine work. Most of them were competent with finger pricks, probably because they do finger pricks frequently when testing children for malaria. Three participants out of 20 (15%) failed the competence test for the practical exercises.

### Discussion

Most of the VHT members in this study had not attended secondary school, contrary to the guidelines of the Ministry of Health of Uganda that recommend that all VHT members should have a minimum qualification of ordinary level (senior school). None of the VHT members had experience in dealing with older people with chronic conditions, since their initial training concentrated on treating or referring children with fever within their communities. All VHT members had knowledge of the common chronic conditions like hypertension and diabetes that affect older people within their communities. Smartphones were widely used within the study setting and a number of the VHT members owned smartphones. The acceptability of using a smartphone intervention for linking older people with chronic conditions to care in future was high among VHT members. We also established that VHT members could be effectively trained to measure blood sugar and blood pressure using digital machines.

The use of community health workers has been an ongoing practice, especially in their contribution towards child survival<sup>32,38–40</sup>. These community health workers have been undertaking various tasks including case management of malaria, diarrhoeal diseases, pneumonia and neonatal sepsis<sup>32,41</sup>. In addition, community health workers have played a role in other areas of maternal and child health, health promotion and linking communities to formal health care<sup>15</sup>.

With an increasing burden of chronic conditions in Uganda, there is need to start exploring ways in which VHTs can contribute to the prevention and control of chronic conditions, especially among older people, who are disproportionately affected by chronic conditions and at the same time have low access to health care facilities<sup>13,42</sup>. Since VHTs stay in the communities where older people with chronic conditions live, they can participate in health education talks about prevention of chronic conditions, screen people for chronic conditions and link them to formal health care facilities. In addition, they could also play a role in monitoring adherence to medication for chronic conditions. In this study, it was not surprising to find out that almost all VHTs had no previous experiences on dealing with problems of older people especially chronic diseases. When the concept of VHTs was first introduced in Uganda, they were

specifically trained to deal with issues of children especially managing fever, diarrhoea and pneumonia. However, as time went on, other issues on maternal and child health were gradually introduced within the activities of VHTs. There will be a need to first train VHTs on the ageing process and generally dealing with older people who have health issues within their communities. In a recent systematic review conducted in low and middle income countries (LMICs), it was shown that compared with standard care, using community health workers in health programmes has the potential to be effective in LMICs, particularly in tobacco cessation, hypertension and diabetes control<sup>43</sup>.

The use of smartphones in Uganda is increasingly being adopted by the public. Although the exact proportion of Ugandans using smartphones is not clearly known, a good number of general public and health professionals use them for various reasons. However, they have not widely been used in health programs in Uganda. The smartphone applications can be used at different points in health care including prevention, linkage to care, diagnosis, prescription, patient self-management and rehabilitation<sup>24</sup>. The availability of smartphones for the public and the willingness to use them by VHT members in this study makes them suitable to use in a future intervention to link older people with hypertension and diabetes to care. A study conducted in Uganda looking at the acceptability and perceptions of community health workers on mHealth in the field of HIV/AIDS established that there was enthusiasm for mHealth and the method was acceptable to community health workers<sup>44</sup>. Another study conducted in a similar study setting in Kalungu district established that community health workers could effectively use smartphones to register pregnancies and birth outcomes<sup>28</sup>.

In this study, a number of inhibiting factors like theft, storage, charging of the smartphones and training were mentioned. These will need to be addressed before an intervention using smartphones to link older people with hypertension and diabetes to care is rolled out.

Our findings show that VHTs in Uganda can be effectively trained and are enthusiastic about an intervention using smartphone applications to link older people with hypertension and diabetes to care. We did not train older people themselves to see if they are willing and able to use a smartphone-guided intervention to self-link to care. Considering the literacy and education level of older people in Uganda, we believed that this was not feasible among this age group. However, we believe that this could be feasible in younger adults who may be able to use such an intervention to self-link to health care facilities in the case of chronic conditions.

In conclusion, VHTs in rural southwest Ugandan will need training in dealing with older people with health problems before they get involved in an intervention using a smartphone application to link older adults with chronic conditions to care.

## Data availability

### Underlying data

LSHTM Data Compass: Data for: Feasibility of village health teams (VHTs) in using a smart phone guided intervention to link older Ugandans with chronic conditions to care. <https://doi.org/10.17037/DATA.00001699><sup>45</sup>

This DOI will remain accessible in the long-term. If LSHTM ceases to operate or the data repository is replaced with another system, arrangements would be made to redirect this DOI to its new location. Researchers interested in obtaining further details on the transcripts are asked to complete the request form operated by the repository. The request form provided to contact the researchers will be maintained for the foreseeable future. Submitted forms should be emailed to Joseph Mugisha ([joseph.mugisha@mrcuganda.org](mailto:joseph.mugisha@mrcuganda.org)) and Janet Seeley ([janet.seeley@mrcuganda.org](mailto:janet.seeley@mrcuganda.org)) for follow-up, as well as sent to the repository administrator who maintains the system. Contact emails can be updated at a later date as required, e.g. in the event that project contacts move to another institution, a new project contact is defined, the institution's name is changed, etc. The transcripts cannot be made openly available for data protection and ethical reasons. Participants are not named in transcripts, but there are sufficient contextual details to allow indirect identification. The consent agreement signed by participants also sets conditions that limit access to authorised people within the study team only. Following receipt of a data request, Dr. Mugisha & Dr. Seeley would enter into a dialogue with the requester to answer their questions (with advice provided by the research data manager, as required). The project will be unable to make the full un-anonymised transcript available, however selected non-identifiable text might be provided to clarify specific points.

### Extended data

LSHTM Data Compass: Data for: Feasibility of village health teams (VHTs) in using a smart phone guided intervention to link older Ugandans with chronic conditions to care. <https://doi.org/10.17037/DATA.00001699><sup>45</sup>

- VHT\_study\_Consent\_form\_English.pdf (Information sheet and consent form)
- VHTs\_Smartphone\_FeasibilityStudy\_InterviewGuide.pdf (Interview guide for study investigating feasibility of village health teams (VHTs) using smartphone-guided intervention to link older Ugandans with chronic conditions to care)

Data are available under the terms of the [Creative Commons Attribution 4.0 International license \(CC-BY 4.0\)](https://creativecommons.org/licenses/by/4.0/).

## Acknowledgements

We are grateful to all the VHT members who took part in this study and for the support of the District Health Office.



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# Open Peer Review

Current Peer Review Status:  

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## Version 2

Reviewer Report 22 December 2021

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### Gerald A. Paccione

<sup>1</sup> Montefiore Medical Center, Bronx, New York, NY, USA

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### Kristen Welch

Montefiore Medical Center, Bronx, New York, NY, USA

We have re-reviewed the manuscript, and find it has successfully addressed most of our questions/issues previously raised. It's a bit redundant in places (e.g. intro and methods descriptions of who the VHTs are), but I/we can approve it for indexing.

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Global Health, program implementation in Africa. General Internal Medicine.

**We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

Reviewer Report 13 December 2021

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### Dorothy Lall

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No further comments to make.

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Primary health care, Non communicable disease control, organisation of chronic care, chronic care models, person centred care, community based models

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.**

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## Version 1

Reviewer Report 15 March 2021

<https://doi.org/10.21956/aasopenres.14144.r28343>

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**Dorothy Lall**

<sup>1</sup> Institute of Public Health, Bengaluru, Karnataka, India

<sup>2</sup> Christian Medical College and Hospital, Vellore, Tamil Nadu, India

This manuscript describes VHTs perspective on being included in the team that manages chronic conditions. While the manuscript is written clearly, there are a few methodological gaps I would like to highlight that I hope will will enable the authors to refine this report.

1. The research question is not clear - it can be stated as an exploratory question to understand VHT experience and willingness to care for elderly with chronic conditions using a smart phone.
2. The methods stated are qualitative however, the sampling described is a probability sampling method - the two are not coherent. A purposive sample with a mix of men and women (if that is contextual), old and young, differing levels of education, social position, would have been appropriate to answer the question.
3. The analysis described uses the term thematic content analysis - either this is content analysis or it is thematic.
4. The analytic process described begins with themes - however in content analysis there is no use of themes and in thematic analysis it is the end result of a coding process.
5. The results for the experiences in dealing with older adults and knowledge of chronic conditions are stated as individual narratives however the analysis should have enabled a general theme if thematic analysis or if content analysis.

6. A table describing the participants would be useful to understand variation in response
7. Only practical competency for testing blood glucose and blood pressure was measured. Identification of whom to screen, when to refer and other programmatic elements including use of smartphone was not assessed. Hence to conclude that VHTs can be effectively trained is an overstatement. To conclude about effectiveness of training before and after comparison would be required.

**Is the work clearly and accurately presented and does it cite the current literature?**

Partly

**Is the study design appropriate and is the work technically sound?**

Partly

**Are sufficient details of methods and analysis provided to allow replication by others?**

Yes

**If applicable, is the statistical analysis and its interpretation appropriate?**

Not applicable

**Are all the source data underlying the results available to ensure full reproducibility?**

Partly

**Are the conclusions drawn adequately supported by the results?**

Partly

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Primary health care, Non communicable disease control, organisation of chronic care, chronic care models, person centred care, community based models

**I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.**

Author Response 30 Aug 2021

**Joseph Mugisha Okello**, Uganda Research Unit, P.O.Box 49, Entebbe, Uganda

This manuscript describes VHTs perspective on being included in the team that manages chronic conditions. While the manuscript is written clearly, there are a few methodological gaps I would like to highlight that I hope will enable the authors to refine this report.

1. The research question is not clear - it can be stated as an exploratory question to understand VHT experience and willingness to care for elderly with chronic conditions using a smart phone.

**Response:** *We have addressed this in the introduction.*

1. The methods stated are qualitative however, the sampling described is a probability sampling method - the two are not coherent. A purposive sample with a mix of men and women (if that is contextual), old and young, differing levels of education, social position, would have been appropriate to answer the question.

**Response:** *Thank you very much for this observation. We did not use purposive sampling but as indicated, we used random sampling. As indicated, we were interested in some characteristics which we considered while selecting the sample. Even in qualitative research, random sampling can be employed depending on the context of the study.*

1. The analysis described uses the term thematic content analysis - either this is content analysis or it is thematic.

**Response:** *As indicated in the methods section, we used thematic content analysis to make it more clear, data were transcribed and translated (the interviews that were conducted in Luganda) into English as soon as possible after completing the interviews. A preliminary review for initial themes and patterns occurring within the data was done by a research assistant and the first author. The initial themes were then discussed by the two of us. Data were anonymised, coded and organised in a code matrix. Patterns and relationships emerging across the data were established and summarised.*

1. The analytic process described begins with themes - however in content analysis, there is no use of themes and in thematic analysis it is the result of a coding process.

**Response:** *Refer to my explanation in number 3 above.*

1. The results for the experiences in dealing with older adults and knowledge of chronic conditions are stated as individual narratives however the analysis should have enabled a general theme if thematic analysis or if content analysis.

**Response:** *Refer to my explanation in number 3 above*

1. A table describing the participants would be useful to understand variation in response

**Response:** *We had included this table in the first manuscript we submitted but during the review process, we were advised to remove the table by the editors.*

1. Only practical competency for testing blood glucose and blood pressure was measured. Identification of whom to screen, when to refer and other programmatic elements including use of smartphone was not assessed. Hence to conclude that VHTs can be effectively trained is an overstatement. To conclude about effectiveness of training before and after comparison would be required.

**Response:** *Thank you for this observation. As indicated, this was a preliminary study to prepare for a bigger study to develop and test a smart phone guided intervention to link older persons with chronic conditions to care. In this study, our objectives to establish the experiences of VHTs in managing older adults with health problems, their knowledge of hypertension and diabetes and their experiences with smartphones. We also investigated whether VHTs could be effectively trained to use a smartphone-guided intervention to link older adults with hypertension and diabetes mellitus to care. The identification of whom to screen and other programmatic elements will be investigated while developing and testing the smart phone guided intervention. With this, we think it was fair to come up with our conclusions.*

We would like to thank both reviewers for their comments and we hope these will improve on the quality of our manuscript.

**Competing Interests:** None

Reviewer Report 02 September 2020

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**Kristen Welch**

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Overall, this is a scoping article that assesses VHTs' capacity/ability to learn new skills for diagnosis of common chronic diseases (CD), and their willingness to adopt electronic aids in providing health care. Since VHTs are already part of the Ugandan health care landscape, and are only paid token amounts if anything for their community service, if the model is shown to be feasible and acceptable, scaling the training country-wide might be plausible.

Thus, the study represents the first step in an intended multi-staged scale-up using VHTs to diagnose CDs at the community level. Community diagnosis is essential if the growing burden of downstream CD complications - like renal failure, heart failure and stroke - can be prevented before the health budgets of resource-poor countries like Uganda are drained. The ultimate goal of the project is extremely important.

One could quibble with the need to collect and report some of the data presented in this initial-stage article, but in the scientific spirit of "assuming nothing" until numbers validate even the most basic assumptions, *the report lays a foundation for future work*. For example, many programs/projects would *assume* that VHTs - elected by their communities, deemed still active and already serving competently in maternal and child health for over 5 years (75% of study subjects), doing many VHT tasks up to now (i.e. "mobilising the communities for health action, promoting health and preventing diseases, treating simple illnesses at home, checking for danger signs at home, referring sick people to health workers and keeping up-to-date village records") - have already *proven* that they have the cognitive skills to understand hypertension and diabetes, and can perform the most basic maneuvers like applying an *electronic* BP cuff or checking finger-stick glucose. After such an accomplished performance record, why should their lack of formal education (true in all of rural Africa), call into question their capacity for these new, fairly straightforward responsibilities? (Working as we have with Ugandan CHWs for 15 years, we've

often thought that if they had received the early and consistent opportunities afforded Westerners or the Ugandan elite, many CHWs would be *chiefs* of medical school departments). So, if we could assume the obvious and move past it i.e. that VHTs could learn the basics of HT and DM from 3 days of lectures and training, the thrust of this first “feasibility pilot” might then have been something like investigating the ideal *duration* of training, or whether groups of available teachers from diverse district hospitals could deliver the same training intervention and realize similar success in their own catchment areas as did the highly-motivated study team in Bukulula.

In that vein, documenting how VHTs know that someone is “old”, or inquiring about whether the 50% of VHTs who don’t yet own a smart-phone would welcome a *free* one, seems unnecessary.

Some specific points bear mentioning:

- The first is in the Introduction, 5<sup>th</sup> paragraph, when reviewing similar literature to substantiate the hypothesis that the program will be successful. The studies referenced show the feasibility of using smartphone technology. Including studies that show that trained lay persons, VHTs, can be successfully taught to measure and recognize chronic diseases, and to accurately refer to health centers would certainly be pertinent. (see below for examples)<sup>1-4</sup>.
- The paper covers a lot of ground, as broad as the intended (future) initiative itself: the rationale of using VHTs in chronic disease, the selection process of 20 VHTs from among the 138 eligible, an overview of the approach to the in-depth interviews (IDIs) with the 20 selected VHTs describing how the data was coded and analyzed (thematic content analysis), an overview of the training topics and practical sessions, the scheme used for evaluation of competency and its application/results, commentaries about VHT attitudes toward smart phones, the acceptability of using one in practice, and their (widely known) risks and challenges in impoverished settings (theft, electricity, cost).

But it could benefit from more focus and/or more clear organization.

It was sometimes hard to know where the paper was headed - with the themes switching rapidly, sometimes after only cursory discussion. Despite describing the IDI methodology in depth, in the end, few insightful observations or results were reported; the content of the training sessions wasn’t described beyond the titles of the topics and the credentials of who gave them; there wasn’t a (“pretest”) evaluation of what the VHTs knew about CDs before the training, or what they newly learned from the training conceptually beyond a technique checklist. Was the focus of the paper on exploring, through IDIs, VHTs as health care providers; VHT knowledge of CDs and ways to expand and make that knowledge functional through a 3-day curriculum; or VHT attitudes toward using smartphones in practice?

- Selection: the selection process of the VHTs could be further clarified. The methods state: “*The District VHT Coordinator used a raffle draw method until all the 20 VHTs were selected. The inclusion criteria were that the VHT had to be a resident of Bukulula sub-county and should have been active as a VHT within the sub-county in the last three months. VHTs were excluded if they were not in a position to participate in the interviews and were not willing to attend the training. The selection of the VHTs was done in consultation with stakeholders within the sub-county and the district including the coordinator of the VHTs within the district.*”  
How many times did the District VHT Coordinator draw from the raffle bin? What percent of



the “draws” were excluded, and for what reason? Was it only the 2 who now lived in Kampala? The section wasn't clear.

Vis-à-vis VHT selection again, how representative of the entire national cohort of VHTs were the VHTs in this study is important vis-à-vis eventual scale-up? A brief discussion of the VHT program nationally, including VHT turnover and duration, would help place the description of this cohort of 20 VHTs in perspective.

- Competence testing: for BP testing, the 5 steps evaluated were named, but not described, limiting knowledge about the message communicated and its replication. How was the person “prepared for BP measurement”? What was the advice about cuff size, and about how to measure BP? Did recording accurately involve an average of measures, the first measure, the 3<sup>rd</sup> in a series? What advice was given to the client? Mentioning the *key points* of the methods evaluated would help communicate the depth of the training.

Also, to help future groups trying to adopt the model, it would be helpful to know more about the most common areas of difficulty in the competency tests, particularly with the 3 VHTs (15%) that failed the evaluation.

Some of the hypertension literature suggests that it actually takes *years* of performing BP measures to do them consistently, accurately, and with minimum variability, and that electronic devices are fraught with the same variability as manual BPs in trained individuals. Time sitting prior to checking BP, back resting against a chair, arm position, talking, cuff tightness, number of BPs taken, etc. all affect the measure. Furthermore, the education literature suggests that nearly half of new knowledge learned decays after 1-3 months. With these types of clinical and educational observations in mind, lack of long-term follow-up of knowledge/skills gained through the training should be noted as a limitation of the present study, and, hopefully, if this is to be proposed as a model for CD screening, addressed by re-assessment of VHT skills in 6-12 months.

- The study makes no mention of what happens if the VHTs begin to identify the 90% of hypertensives and diabetics in Uganda who are unaware of their disease. Refer them to health centers with few staff, fewer medications, and little experience treating chronic disease? Good clinicians and health systems know that screening shouldn't be offered for a disease if societies/families don't have the resources to treat. So, without reliable treatment that's affordable to the people, advocacy must be the principle objective of community-based screening. The model is not to be scaled until treatment is assured.
- The study identifies some of the barriers the VHTs foresee in using smartphones, probably stemming from their own experiences with the devices (50% of VHTs already own smart phones, indicating to these readers that the area studied is more affluent/developed than most regions of rural Uganda). These issues can probably be addressed more directly, informing the likely timing of successful rollout of the smartphone model: e.g. what percentage of the VHTs have access to electricity to charge phones and how much of an impediment does this represent in different regions of Uganda?
- Summary themes or conclusions expressed in different sections of the paper are not entirely consistent with the data presented: for example, the **title of the article** reads:

*“Training village health teams (VHTs) to use a smartphone-guided intervention to link older Ugandans with hypertension and diabetes to care”*. But the article doesn't describe training to use a smartphone-guided intervention at all.

In the **abstract, the objective** of the study is stated: *“we conducted this study in rural Uganda to establish the experiences of VHTs in managing older adults with health problems, their knowledge of hypertension and diabetes, and their understanding of referral systems. We also explored their experiences with smartphones and whether VHTs could be effectively trained to use a smartphone-guided intervention...”* The main objective of the article as stated here seems to be on understanding the experiences of VHTs in managing CDs in the elderly, but aside from a few highly selected anecdotes from VHTs, not much data are provided along that line. And again, there are no data presented about whether VHTs could be trained to use a smartphone intervention, aside from their willingness to do so despite potential challenges on the horizon.

Finally, the last 4 lines of the article read: ***In conclusion***, *VHTs in rural southwest Ugandan will need training in dealing with older people with health problems before they get involved in an intervention using a smartphone application to link older adults with chronic conditions to care.* While this is undoubtedly true - that VHTs need to know how to check BP and blood sugar to take care of adults with HTN and DM - isn't this the premise of the training and of the report? It seems more like a “given” than a “conclusion” based on data presented in the article.

These various summaries, conclusions and overarching objectives can be more accurately and consistently expressed.

#### **Conclusions:**

Overall, this report is the first phase of an ambitious concept to utilize VHTs, previously trained in child and maternal health, in chronic disease care of adults.

We feel it should be indexed, after addressing as many of the above limitations as possible -- many of which can be substantially remedied by tighter organization, clarification, consistency, and selective expansion of content.

#### **References**

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**Is the work clearly and accurately presented and does it cite the current literature?**

Partly

**Is the study design appropriate and is the work technically sound?**

Yes

**Are sufficient details of methods and analysis provided to allow replication by others?**

Partly

**If applicable, is the statistical analysis and its interpretation appropriate?**

Not applicable

**Are all the source data underlying the results available to ensure full reproducibility?**

Partly

**Are the conclusions drawn adequately supported by the results?**

Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Global Health, program implementation in Africa. General Internal Medicine.

**We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however we have significant reservations, as outlined above.**

Author Response 30 Aug 2021

**Joseph Mugisha Okello**, Uganda Research Unit, P.O.Box 49, Entebbe, Uganda

Overall, this scoping article assesses VHTs' capacity/ability to learn new skills for diagnosis of common chronic diseases (CD), and their willingness to adopt electronic aids in providing healthcare. Since VHTs are already part of the Ugandan health care landscape, and are only paid token amounts if anything for their community service, if the model is shown to be feasible and acceptable, scaling the training countrywide might be plausible.

Thus, the study represents the first step in an intended multi-staged scale-up using VHTs to diagnose CDs at the community level. Community diagnosis is essential if the growing burden of downstream CD complications - like renal failure, heart failure and stroke - can be prevented before the health budgets of resource-poor countries like Uganda are drained. The ultimate goal of the project is extremely important.

One could quibble with the need to collect and report some of the data presented in this initial stage article, but in the scientific spirit of "assuming nothing" until numbers validate even the most basic assumptions, *the report lays a foundation for future work*. For example, many programs/projects would *assume* that VHTs - elected by their communities, deemed still active and already serving competently in maternal and child health for over 5 years (75% of study subjects), doing many VHT tasks up to now (i.e. "mobilising the communities for health action, promoting health and preventing diseases, treating simple illnesses at

home, checking for danger signs at home, referring sick people to health workers and keeping up-to-date village records”) – have already *proven* that they have the cognitive skills to understand hypertension and diabetes, and can perform the most basic manoeuvres like applying an *electronic* BP cuff or checking finger-stick glucose. After such an accomplished performance record, why should their lack of formal education (true in all of rural Africa), call into question their capacity for these new, straightforward responsibilities? (Working as we have with Ugandan CHWs for 15 years, we have often thought that if they had received the early and consistent opportunities afforded Westerners or the Ugandan elite, many CHWs would be *chiefs* of medical school departments). So, if we could assume the obvious and move past it i.e. that VHTs could learn the basics of HT and DM from 3 days of lectures and training, the thrust of this first “feasibility pilot” might then have been something like investigating the ideal *duration* of training, or whether groups of available teachers from diverse district hospitals could deliver the same training intervention and realize similar success in their own catchment areas as did the highly-motivated study team in Bukulula. In that vein, documenting how VHTs know that someone is “old”, or inquiring about whether the 50% of VHTs who do not yet own a smart-phone would welcome a *free* one, seems unnecessary.

**Some specific points bear mentioning:**

1. The first is in the Introduction, 5th paragraph, when reviewing similar literature to substantiate the hypothesis that the program will be successful. The studies referenced show the feasibility of using smartphone technology. Including studies that show that trained laypersons, VHTs, can be successfully taught to measure and recognize chronic diseases and to accurately refer to health centres would certainly be pertinent. (See below for examples)1-4.

**Response:** *Thank you very much for this observation. We have added a sentence to show that studies conducted elsewhere have shown that none medical persons including community health workers can be taught to recognise chronic diseases and are able to refer those screened for chronic diseases for further management. The four references have now been cited in the introduction section.*

1. The paper covers a lot of ground, as broad as the intended (future) initiative itself: the rationale of using VHTs in chronic disease, the selection process of 20 VHTs from among the 138 eligible, an overview of the approach to the in-depth interviews (IDIs) with the 20 selected VHTs describing how the data was coded and analyzed (thematic content analysis), an overview of the training topics and practical sessions, the scheme used for evaluation of competency and it’s application/results, commentaries about VHT attitudes toward smart phones, the acceptability of using one in practice, and their (widely known) risks and challenges in impoverished settings (theft, electricity, cost). But it could benefit from more focus and/or more clear organization. It was sometimes hard to know where the paper was headed - with the themes switching rapidly, sometimes after only cursory discussion. Despite describing the IDI methodology in depth, in the end, few insightful observations or results were reported; the content of the training sessions wasn’t described beyond the titles of the topics and the credentials of who gave them; there wasn’t a (“pretest”) evaluation of what the VHTs knew about CDs before the training, or what they newly learned from the training conceptually beyond a technique checklist. Was the focus of the paper on exploring, through IDIs, VHTs as health care providers; VHT knowledge of CDs and ways to expand and make that knowledge functional through a 3-day

curriculum; or VHT attitudes toward using smartphones in practice?

**Response:**

1. Selection: the selection process of the VHTs could be further clarified. The methods state: *“The District VHT Coordinator used a raffle draw method until all the 20 VHTs were selected. The inclusion criteria were that the VHT had to be a resident of Bukulula sub-county and should have been active as a VHT within the sub-county in the last three months. VHTs were excluded if they were not in a position to participate in the interviews and were not willing to attend the training. The selection of the VHTs was done in consultation with stakeholders within the sub-county and the district including the coordinator of the VHTs within the district.”*

How many times did the District VHT Coordinator draw from the raffle bin? What percent of the “draws” were excluded, and for what reason? Was it only the 2 who now lived in Kampala? The section was not clear. Vis-à-vis VHT selection again, how representative of the entire national cohort of VHTs were the VHTs in this study is important vis-à-vis eventual scale-up? A brief discussion of the VHT program nationally, including VHT turnover and duration, would help place the description of this cohort of 20 VHTs in perspective.

**Response:** *As we have indicated in the manuscript, the study area (Bukulula Sub County) comprises of 69 villages. Each village is supposed to have two VHTs in accordance with the Uganda Ministry of health guidelines. Thus, the total number of VHTs in this sub county were 138. As indicated, since we were going to collect qualitative data and since this was a preliminary study, 20 VHTs would give us enough data to answer our research questions. To select the 20 from 138, a raffle method was used. Names of all the 138 villages were written on small pieces of paper (one paper for each village). These were put in the box and churned. The district VHTs coordinator would pick a paper and then churning would be done again. This process was repeated until 20 papers were picked. Twenty VHTs from the villages that were picked were selected to participate in the study. All the VHTs within the sub county fulfilled the inclusion criteria. Out of the 20 that were selected, only two were replaced because they stayed and worked very far away in Kampala the capital city of Uganda. It is debatable on how representative were the VHTs selected for this study on the entire cohort of VHTs in Uganda. What is certain is that the guidelines for selection of VHTs in Uganda are uniform. They should have completed senior 4 (ordinary level of education in Uganda), they should be selected by members from their own communities, they should be willing to work voluntarily and should be people who understand their communities very well. we have re arranged this subsection and added a subsection in the methods section on VHTs in Uganda.*

1. Competence testing: for BP testing, the 5 steps evaluated were named, but not described, limiting knowledge about the message communicated and its replication. How was the person “prepared for BP measurement”? What was the advice about cuff size, and about how to measure BP? Did recording accurately involve an average of measures, the first measure, the 3rd in a series? What advice was given to the client? Mentioning the *key points* of the methods evaluated would help communicate the depth of the training. Also, to help future groups trying to adopt the model, it would be helpful to know more about the most common areas of difficulty in the competency tests, particularly with the 3 VHTs (15%) that failed the evaluation. Some of the hypertension literature suggests that it actually takes *years* of performing BP measures to do them consistently, accurately, and with minimum variability, and that

electronic devices are fraught with the same variability as manual BPs in trained individuals. Time sitting prior to checking BP, back resting against a chair, arm position, talking, cuff tightness, number of BPs taken, etc. all affect the measure. Furthermore, the education literature suggests that nearly half of new knowledge learned decays after 1-3 months. With these types of clinical and educational observations in mind, lack of long-term follow-up of knowledge/skills gained through the training should be noted as a limitation of the present study, and, hopefully, if this is to be proposed as a model for CD screening, addressed by reassessment of VHT skills in 6-12 months.

**Response:** Thank you for raising these important issues. We followed an SOP we use in my Unit for measuring blood pressure in older people using a digital blood pressure machine. Details on preparation of participants for BP measurements are described in the SOP. We have attached the copy of the SOP.

1. The study makes no mention of what happens if the VHTs begin to identify the 90% of hypertensives and diabetics in Uganda who are unaware of their disease. Refer them to health centres with few staff, fewer medications, and little experience treating chronic disease? Good clinicians and health systems know that screening should not be offered for a disease if societies/families do not have the resources to treat. So, without reliable treatment that is affordable to the people, advocacy must be the principle objective of community based screening. The model is not to be scaled until treatment is assured.

**Response:** Thank you very much for this observation. You are right. During the designing of this study, this point was considered. Originally, we had planned to pilot this intervention in people aged 35 years and above. If screening for hypertension and diabetes was done among this category and 90% of the people with hypertension and diabetes identified and referred, this would definitely overwhelm the health systems. Because of this, we decided to only consider the age category of 60 years and above. These only make up 3% of the Ugandan Population. So even if 90% of this category were screened and found to have hypertension and diabetes, these would be adequately handled by the health systems. In addition to this, all public health facilities in Uganda at the level of health centre IV (health centre at constituency level) are headed by medical doctors and stocked with hypertension and diabetes medication. These doctors would be able to handle the older people (60 years and over) screened and found with hypertension or diabetes mellitus.

1. The study identifies some of the barriers the VHTs foresee in using smartphones, probably stemming from their own experiences with the devices (50% of VHTs already own smart phones, indicating to these readers that the area studied is more affluent/developed than most regions of rural Uganda). These issues can probably be addressed more directly, informing the likely timing of successful rollout of the smartphone model: e.g., what percentage of the VHTs have access to electricity to charge phones and how much of an impediment does this represent in different regions of Uganda?

**Response:** Thank you for this comment. The area studied is not actually affluent/developed than most of rural Uganda. Actually, smart phones are now available in most of the villages in

*Uganda. However, electricity coverage is not good and it is very difficult to estimate the proportion of VHTs who have access to electricity. Some village homes use solar power but it's also not widely available.*

1. Summary themes or conclusions expressed in different sections of the paper are not entirely consistent with the data presented: for example, the **title of the article** reads: "Training village health teams (VHTs) to use a smartphone-guided intervention to link older Ugandans with hypertension and diabetes to care". But the article does not describe training to use a smartphone-guided intervention at all. In the **abstract, the objective** of the study is stated: "we conducted this study in rural Uganda to establish the experiences of VHTs in managing older adults with health problems, their knowledge of hypertension and diabetes, and their understanding of referral systems. We also explored their experiences with smartphones and whether VHTs could be effectively trained to use a smartphone-guided intervention..." The main objective of the article as stated here seems to be on understanding the experiences of VHTs in managing CDs in the elderly, but aside from a few highly selected anecdotes from VHTs, not much data are provided along that line. Again, there are no data presented about whether VHTs could be trained to use a smartphone intervention, aside from their willingness to do so despite potential challenges on the horizon.

**Response:** *Thank you very much for these observations. As indicated in the manuscript, almost all VHTs had no experiences in managing chronic conditions in older people. Almost all of the VHTs mentioned that they had only been trained to manage children with malaria, pneumonia and diarrhoeal diseases. This is the reason why we do not have data on experiences of managing chronic conditions in older persons. In addition, this is the reason we concluded that VHTs in rural southwest Ugandan will need training in dealing with older people with health problems before they get involved in an intervention using a smartphone application to link older adults with chronic conditions to care. Lastly, this study was conducted in preparation for a bigger study to develop a smart phone guided intervention. We have revised the manuscript to indicate to readers that we did not already have a smart phone guided intervention and as such, we could not have trained the VHTs on this.*

1. Finally, the last 4 lines of the article read: **In conclusion**, *VHTs in rural southwest Ugandan will need training in dealing with older people with health problems before they get involved in an intervention using a smartphone application to link older adults with chronic conditions to care.* While this is undoubtedly true - that VHTs need to know how to check BP and blood sugar to take care of adults with HTN and DM - isn't this the premise of the training and of the report? It seems more like a "given" than a "conclusion" based on data presented in the article. These various summaries, conclusions and overarching objectives can be more accurately and consistently expressed.

**Response:** *thank you very much. As we already indicated in response to issue 7 above, we thought VHTs would be able to describe their experiences on managing older people with chronic conditions. However, after conducting the interviews, we established that almost all the 20 VHTs had no previous experiences of managing older people with chronic conditions. Never the less, we have revised our conclusion to make it better.*

**Conclusions:**

Overall, this report is the first phase of an ambitious concept to utilize VHTs, previously trained in child and maternal health, in chronic disease care of adults. We feel it should be indexed, after addressing as many of the above limitations as possible – many of which can be substantially remedied by tighter organization, clarification, consistency, and selective expansion of content

***Competing Interests:*** None

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