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Article

Uganda mountain community health system perspectives and capacities towards emerging infectious disease surveillance

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Abstract: In mountain communities like Sebei, Uganda, that are highly vulnerable to emerging and reemerging infectious diseases, community-based surveillance plays an important role in the monitoring of public health hazards. In this survey, we explored capacities of Village Health Teams (VHTs) in Sebei communities of Mount Elgon in undertaking surveillance tasks for emerging and reemerging infectious diseases in the context of a changing climate. We used participatory epidemiology techniques to elucidate VHTs' perceptions on climate change and public health and assess their capacities in conducting surveillance for emerging and reemerging infectious diseases. Overall, VHTs perceived climate change to be occurring with wider impacts on public health. However, they have inadequate capacities in collecting surveillance data. The VHTs lack transport to navigate through their communities and have insufficient capacities in using mobile phones for sending alerts. They do not engage in reporting other hazards related with the environment, wildlife and domestic livestock that would accelerate infectious disease outbreaks. Records are not maintained for disease surveillance activities and the abilities of VHTs to analyze data are also limited. However, VHTs have access to platforms that can enable them to disseminate public health information. The VHTs thus need to be retooled to conduct their work effectively and efficiently through equipping them with adequate logistics and knowledge on collecting, storing, analyzing, and relaying data, which will improve infectious disease response and mitigation efforts.

Keywords: Alerts, Village Health Teams, Community Based Surveillance, Integrated Disease Surveillance and Reporting, Elgon, Climate Change, One Health

1. Introduction

Emerging and re-emerging infectious diseases continue to threaten human health across the globe. The current COVID-19 pandemic exemplifies the wider impacts of such diseases on different aspects of the economy, human livelihoods, and wellbeing [1-3]. It is thus crucial that communities are prepared for the next pandemic to minimze such impacts. Estimates indicate about three quarters (75%) of the emerging and re-emerging infectious diseases are zoonotic in nature [4,5]. A zoonotic disease is an infectious disease that jumps from a non-human animal to humans through direct contact or through food, environment, water or through unconventional agents [4]. These diseases present a major public health crisis because of the intricate relationship between humans and animals through, for example, food production and distribution practices and the interconnectedness of human populations [6].

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Whereas domestic and wild animals are important hosts for zoonotic disease pathogens, human encroachment on the ecological systems has exacerbated spillover of such pathogens to humans [7]. Pathogen spillover from an animal reservoir to a human is a complex process involving many barriers at the reservoir, environment, and host levels; when these barriers are weakened in such a way that increases pathogen pressure in the reservoir or environment, exposure at the animal-human interface, or susceptibility to infection, the probability of spillover becomes more likey [8]. Common drivers of pathogen emergence include economic development and land use changes; international travel and commerce; human behaviour and demographics; changes in ecosystems; changes in human susceptibility; and hospital-associated events [8]. Disruption of the ecosystems by humans has been occurring in the past decades with an increase in the recent past [9,10]. For instance, between 2004 to 2014, it was estimated that Ebola disease outbreaks in Central and West Africa correlated with hotspots of forest fragmentation [11]. Similarly, highly fragmented landscapes in Bangladesh were found to be high risk areas for Nipah virus disease outbreaks [12]. The recent ecosystem disruptions have mainly been fuelled by efforts to ensure sustained food supply through agricultural production, processing and distribution[9,13], but consequently have also increased contact at the human-animal interface. The human population is expected to reach 9.7 billion by 2050; 2.5 billion of this population will be in Africa [14], urbanization characterized by rapid intensification of agriculture, socioeconomic change, and ecological fragmentation will occur [15]. Projections on food demands indicate a 60% increase in sub-Saharan Africa [16,17] implying increased ecosystem disruptions and an associated increase in vulnerability at the human-animal interface that may weaken barriers to spillover and facilitate the movement of disease-causing pathogens to humans.

Human influence has also accelerated climate change through land use changes and increased greenhouse gas emissions, further disrupting wildlife ecosystems and increasing the human-animal interface [18,19]. The changing climate will have both direct and indirect consequences not only on the spillover events of such pathogens but also on their transmission within and among human populations. For example, climate change may accelerate range shifts of different species that could be natural hosts of pathogens that can spillover to humans causing disease [20]. Besides effects on the distribution of natural hosts, climate change might also undermine food security presenting additional challenges for disease management in a health infrastructure that is already stressed or underdeveloped. These pressures have recently been witnessed during the management of SARS-COV-2 response efforts especially in Africa where most households live on "a hand to mouth" strategy where one has to look for what to eat every day and nothing gets stored for future consumption [21-23]. In mountain communities that have been cited to be among the highly sensitive groups to climate change, such infectious disease scenarios will be pose fundamental impacts on human populations [24]. This impact has been evidenced for other diseases like malaria whose belt has been documented to expand in mountain areas like Mt Elgon [25-27]. Climate change tends to alter the environmental conditions providing suitable habitats for disease vectors e.g. Malaria. Rapid urbanization that is occurring in these mountain areas will further accelerate disruption of ecosystems increasing the human-animal interface and disease pathogen spillover events [28]. Furthermore, climate change together with other factors like land degradation on mountain slopes may result into heavy rains causing disasters like landslides evidenced recently evidenced in Mt Elgon [29]. Such disasters can facilitate disease outbreaks associated with water e.g. cholera. Collectively, these pressures call for the design of

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public health interventions that are sensitive to mountain communities during management of infectious disease outbreaks.

Uganda has received credit for supporting the management of disease outbreaks in other countries including the 2014-2015 Ebola Virus Disease outbreak in West Africa [30]. The country's efforts to prevent spillover across national borders of the recent Ebola outbreak in the neighboring Democratic Republic of Congo strengthened such recorgnition. Despite this credit, Uganda continues to experience regular disease outbreaks of diverse pathogens including yellow fever [31], tuberculosis [32], measles [33,34], and hepatitis E [35], and re-emergence of diseases after many years, like Rift Valley fever [36]. Moreover, some of these disease outbreaks are always recurring and have a pandemic potential. Based on the previous experiences, it is expected that the country's health system has greatly improved to prevent spillover events, ensure early detection and response to disease such diseases. Unfortunately, there seems to be inadequate capacities of the health system to prevent, detect, and respond to such disease events. Previous disease outbreaks were identified through detecting abnormal increase in deaths and severe signs and symptoms presented by humans. This approach is not adequate as it does not increase potential for detection of an index case. Early detection of index cases are critical to deploy early actions to prevent escalation of the disease and spread to different geographic areas.

In mountain communities that are often faced with inadequate infrastructure for relaying information, community-based disease surveillance requires adequate empowerment to navigate through hard-to reach areas. Despite the occurrence of eight infectious disease outbreaks in Uganda in 2017-2018 alone, viral hemorrhagic fevers were not reported according to the International Health Regulations, which creates a significant public health and biosecurity threat [37]. Besides infrastructure, the changing climate and human demographic characteristics increases their vulnerability to infectious disease outbreaks [24]. In countries like Uganda, mountain communities like Sebei in Mt Elgon have witnessed disease outbreaks that were never reported before. These among others include; Anthrax [38], Polio [39], Cholera and Marburg [40]. Besides, the malaria belt has expanded in the area [27], thus calling for enhanced interventions to prevent further disease outbreak events. This survey thus sought to elucidate capacities of the VHTs in ensuring community-based surveillance in Kween district areas of Mt Elgon.

2. Materials and Methods

Study site, study population, and sampling strategy

This study was conducted as part of the Mountain Sentinels fellowship program that involved enhancing the resilience of mountain communities during the COVID-19 pandemic that has widely undermined the livelihoods of communities. During this fellowship, a research project on enhancing community-based surveillance for infectious diseases in Sebei community of Mount Elgon was proposed (Fig 1). This was an action-oriented research project that involved training of communities on emerging and re-emerging infectious diseases and their causes, climate change and environmental degradation, community-based disease surveillance and its importance. The engagement targeted all the communities living in all the altitudinal zones of the mountain. Kween has recently experienced several infectious disease outbreaks including Marburg, anthrax, cholera, foot and mouth disease and measles [38,40]. The changing climate change has

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led to the expansion of malaria belt towards the higher altitudes. Besides infectious diseases outbreaks, the area experiences landslides and previously conflicts from the neighboring communities of Karamoja and Pokot.

This study was conducted in 10 randomly selected villages in Kween district in Mount Elgon areas of Uganda during the months of November and December 2020. The village health teams (VHTs) that form part of the community health care workers (at the "Health Center I" according to the structure of Uganda's health system) of the Ugandan health system were selected. The VHTs were selected because they stay and work closely with their communities and have the mandate to report health related events within their communities. The villages were purposively selected based on their location and availability of a VHT member.

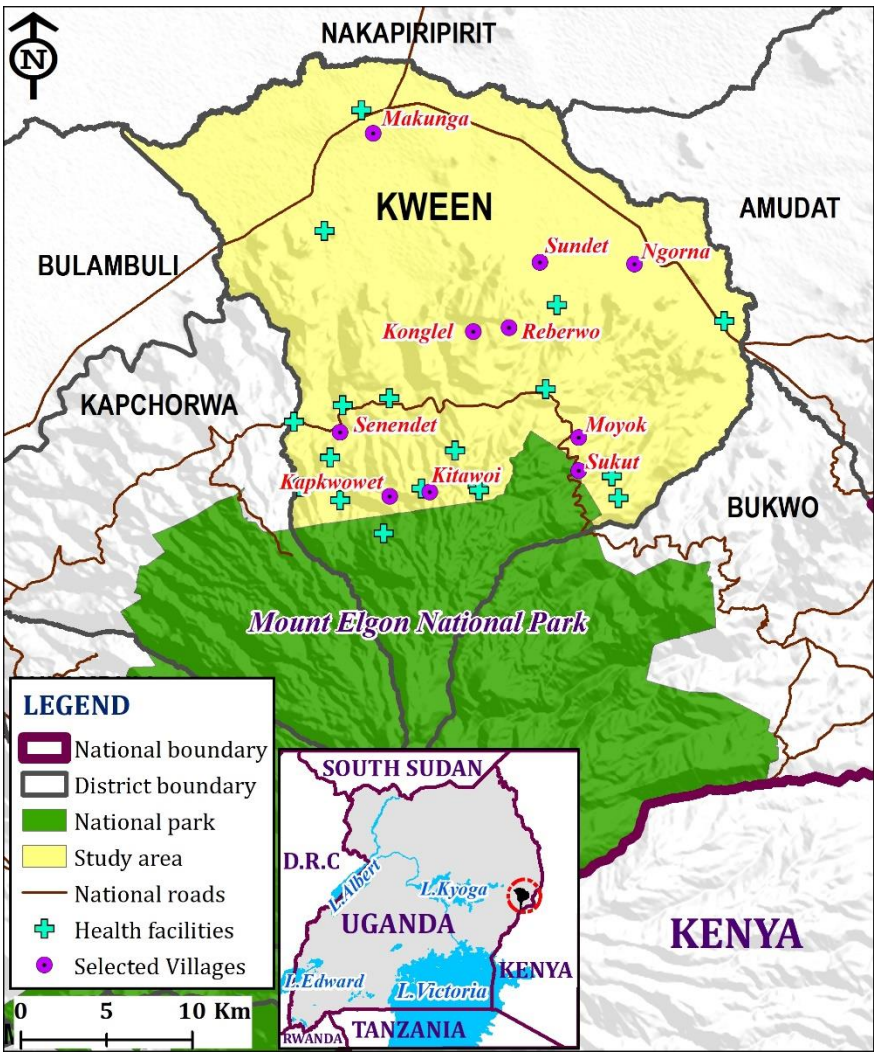

Figure 1: Location of Kween district

Data collection

A semi-structured interview questionnaire (Supplementary Materials) was used for collection of qualitative and quantitative data. The questionnaire consisted of three sections: 1) socio-demographic characteristics, 2) perceptions on climate change and public health aspects, and 3) infectious disease surveillance capacities (including collection, analysis, and dissemination). The questionnaires were administered to the Focus Group Discussion members that formed part

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of the team engaged. There were ten (10) Focus Group Discussions held in the study area with members in each group not exceeding five (5) and not less that three (3). Written informed consent was sought from them about their willingness to participate in the interview. This was done after explaining to them about the study and the activity broadly.

Scoring of perceptions

Perceptions on climate change and public health as well as infectious disease surveillance capacities that were answered positively were scored one (1) while those that were answered negatively were scored zero (0). All questions were given equal weight, and missing responses were not scored. Meanwhile, responses where individuals had no knowledge about were scored zero (0). The perceptions score for each study participant were used to compute the percentage scores.

Data analysis

Data were analyzed using previously-described methods, with some modifications made [41]. Data captured as a score, such as responses regarding different aspects of climate change and surveillance, are reported as means and percentages (Table 1.1, Figures 2-4). Meanwhile, qualitative data were transcribed and analyzed using thematic analysis to understand people's opinions regarding climate change and public health as well as disease surveillance. Themes on disease surveillance components of data collection, analysis and dissemination were explored among the Village Health teams to elucidate their capacities in undertaking disease surveillance tasks. The themes on climate change and its public health impacts were also explored. Thematic analysis was conducted using NVivo Version 12 (https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/), a software program that is often used for acquiring deep insights regarding qualitative data which can be in form of unstructured text.

3. Results

3.1 Sociodemographic characteristics

In total, 48 Village Health Team professionals were interviewed from 10 different villages throughout the Kween District. Focus groups from each village comprised 3-5 participants. The particpants reared livestock (mainly goats and cattle) and had access to nearby schools (Table 1). All utilized both modern medicine and services from traditional healers (Table 1).

Table 3.1: Sociodemographic characteristics

Village*	Kongl el	Reber wo	Ngorn a	Sundet	Kita woi	Kapkwo wet	Sukut	Senen det	Magun ga	Moyo k
Average herd size (Number of cows)	12±3	14±3	19±2	22±1	6±4	12±9	7±2	12±1	16±3	13±3
Average herd size (number of sheep)	1±1	0	3±5	5±3	0	0	0	0	1±1	2±7
Average herd size goats	16±7	13±1	22±2	26±6	11±3	5±5	14±2	13±4	11±2	12±9
Average farm size (ha)	1±2	1.2±5	12±1	25±3	1±3	1.3±1	1.1±2	1±3	1.2±2	1±2
Level of access to water source point	Medi um	Yes	Low	Low	Medi um	Medium	Mediu m	Mediu m	Low	Medi um
Access to electricity	No	No	No	No	No	No	No	No	No	Yes

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Number of nearby primary schools	4	3	2	2	4	2	2	1	3	4
Number of nearby secondary schools	2	2	1	1	2	2	2	2	2	2
Where do you access health services? Traditional healer or western medicine?	Both	Both	Both	Both	Both	Both	Both	Both	Both	Both

* *Data are expressed as the mean number ± standard deviation*

3.2 Perceptions on climate change and impacts public health

Rainfall and temperature

Respondents from each of the ten (10) villages were in complete agreement that rainfall onset and cessation of rainy seasons are highly variable. They also noted that quantities of rainy were abnormally high/ low during some periods with more flooding experienced. Dry periods during rainy season were noted to be more common and lengthy now compared to the past. Respondents from nine out of ten villages agreed that droughts came more often, and that hailstorms were more frequent.

Similarly, all the respondants agreed that temperature in both rainy and wet seasons has increased.

"These days, the rainfall has greatly changed. Sometimes we receive abnormally large quantities of rainfall and sometimes it gets extremely low. The onset and cessation of these rains have greatly changed and hard to predict". A VHT member noted

"Temperature sometimes gets so high that even our water wells dry up. This is common now unlike in the past" . A VHT member noted

Climate change events

Frost was noted to be more common and intense now affecting crop produce especially in areas near the Mt Elgon National park. The fog, especially in areas near the park, was noted to have reduced. Flooding within the region was noted to have increased in the area and was attributed to the change in climate by survey participants

"These days, floods are more common and especially in the flat areas of Greek, Ngenge and Sundet. This was not the case in the past because these rains at times come when they are too much". A VHT member noted

Climate change impacts on health

Regarding impacts of climate change on health, respondents generally agreed that climate change has led to the expansion of the range of vectors that transmit diseases causing pathogens. An example that was raised was the mosquitoes which are now common in some higher altitude areas causing malaria. The new diseases that affect livestock and humans were also noted to be common now because of the change in climate. The respondants went ahead to list examples of diseases that are emerging within their community because of climate change: Marburg Virus Disease, Anthrax, and Foot and Mouth disease. Food systems were also noted to have been disrupted by changes in climate.

"The malaria cases are now common in cold areas near Mt Elgon national park and yet they were not there in the past. The mosquitoes are moving to these areas and it is because of the warming temperature there". A VHT member noted

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"New diseases are now common that affect humans and livestock. These diseases include "mworiondet" (Foot and Mouth Disease), Marburg, Anthrax and Cholera. These diseases are coming up because of the changing climate associated with floods and high temperature". A VHT member noted

"We experience many environmental events like mud sliding, flooding of the rivers and yet this would cause diseases and also destroy our crops". A VHT member noted

3.3 Surveillance capacities

Data collection

Regarding data collection capacities, all the VHTs had emergency contacts for reporting public health events within their communities to the government authorities (Figure 2). Up to half (50%) of the VHT participants owned private mobile phones and they had been trained on the signs and symptoms of common infectious diseases within their communities. Only 40% of the respondents knew how to use mobile phones to send text messages or even use them for voice calls. Similarly, only 40% of the respondents had access to the nearby health facility as only 10% of total number of respondents had means of transport (Figure 2). Regarding record keeping, only 20% of the respondents noted to keep records of their activities. Regarding the kind of diseases reported that may not occur in humans, only 30% of the VHTs reported diseases that affect their domestic livestock while none of them reported diseases in wildlife and environmental hazards like floods (Figure 2).

"I have a mobile phone but I am not well-versed with typing messages. I sometimes just give a friend/my child to type and send the message. But it is too much work because I have to explain to the person helping me to type and yet there is no payment for the service". A VHT member noted

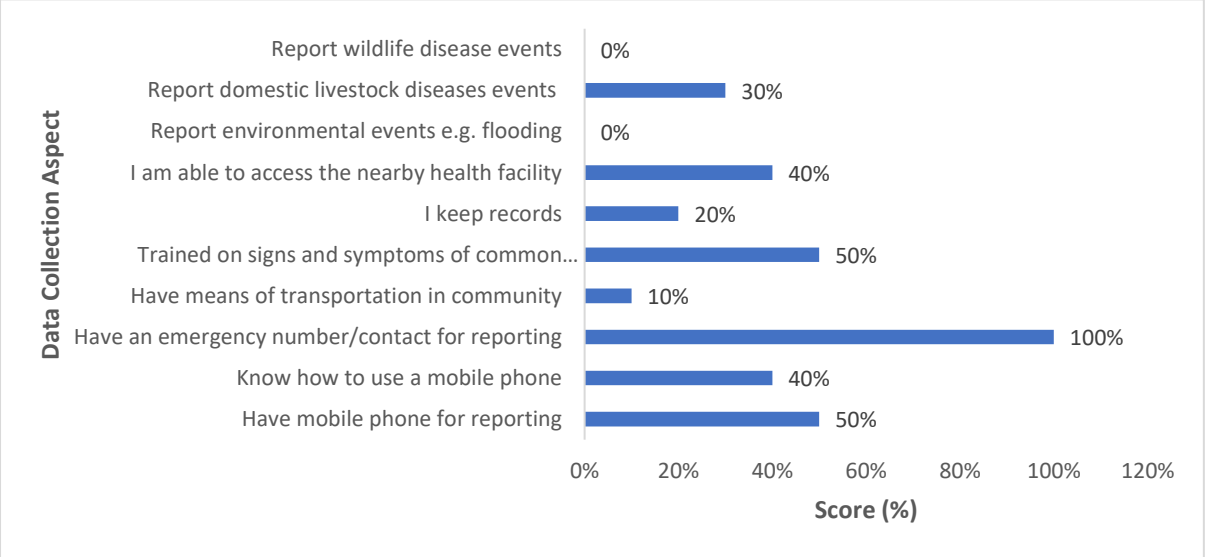

Figure 2. Percentage of Village Health Team members across all ten villages who responded positively to disease detection and reporting capacities in the Kween District, Uganda, 2020

Data analysis

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All VHTs (100%) engaged knew how to identify the signs and symptoms of common infectious diseases within their community (Figure 3). Meanwhile only 10% of them knew how to analyze the data they collected using bar graphs while none of them knew how to draw line graphs for the disease trends within their communities.

"We have been taught several times about the signs and symptoms of common diseases that's why we are able to identify such patients in the community"

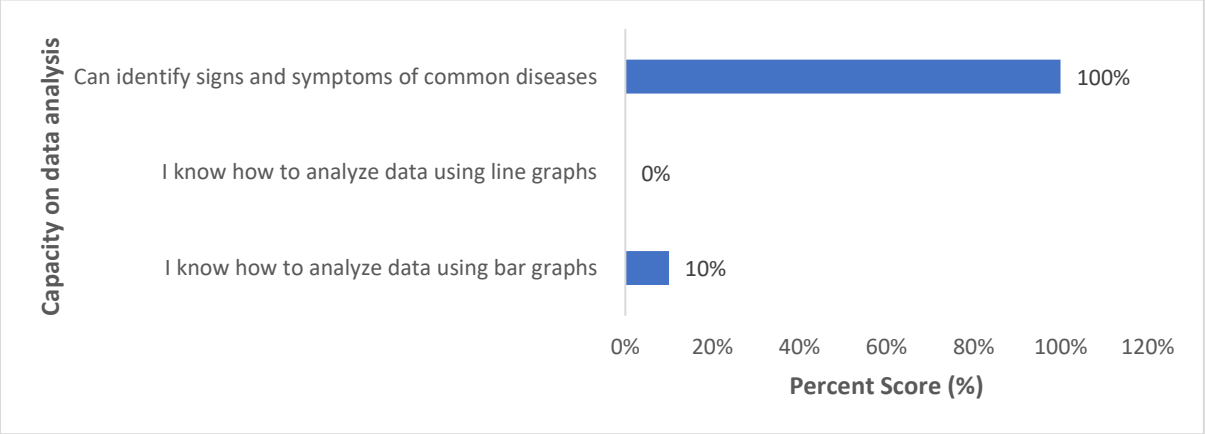

Figure 3. Data analysis capability of Village Health Team members across all ten villages in the Kween District, Uganda, 2020.

Information dissemination

Regarding dissemination of information, all VHTs (100%) engaged had access to a venue for dissemination of health-related information (Figure 4). They all (100%) also had stationary for training and dissemination of public health information, and were part of the social group that can allow for dissemination of public health information. Access to radio stations and nearby schools for dissemination of public health information was limited for up to half (50%) of the respondents (Figure 4).

"I do community walks sometimes and meet with my community members. I can pass on the message on public health events while paying them a visit". A VHT member noted

"I am part of the village savings team and sometimes I disseminate health related messages to my teammates whenever we meet. I would reach out to the broader community but it is hard to reach out to all areas as it needs a transport means". A VHT member noted

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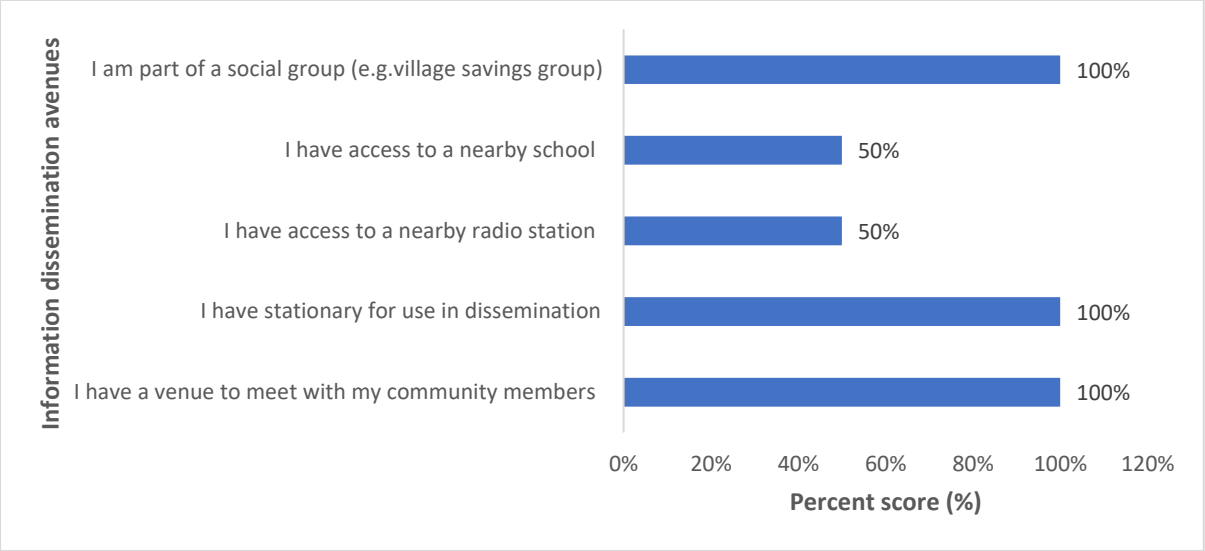

Figure 4. Opportunities for health information dissemination by Village Health Teams in the Kween District, Uganda

4. Discussion

Here, we present the first study that focuses on community based disease surveillance in the changing climate within the mountain communities of Uganda. Specifically, we employed qualitative approaches to assess public health perceptions and disease reporting infrastructure among rural mountain communities in Eastern Uganda that are critical for responding to emerging infectious disease events. This area has experienced increasing infectious disease outbreaks in recent years, and increased incidence of highland malaria consistent with climate change influence on mosquito vector distribution [25-27, 38, 40 & 42]. The ability to prevent, detect and respond early to these events at the village level is paramount. To this end, we interviewed Village Health Team workers from 10 villages in the Kween District to gain a preliminary understanding of the peoples' perceptions on climate change and infectious diseases, and importantly, to determine what shortcomings are present in the disease reporting infrastructure that could be improved for more effective public health protection.

Previous studies on community perceptions regarding climate change within Mount Elgon areas of Kapchorwa also occupied by Sebei indicated highly variable rainfall onset and offset recently [43-45]. This result is similar to that of this current study in which VHTs (who are part of the community) perceived fluctuations in important climate variables (rainfall and temperature to be highly variable currently). Additionally, climate events including drought and highly erratic rainfall resulting into floods and reduced food access were also noted in this current study. Although most of these studies related climate change with food security, climate change is generally perceived to be occuring. Previous data within Kween district and in the whole of Mount Elgon indicated highly variable rainfall and temperature recently compared to the past [27] . This is consistent with opinions from the VHTs in this current study regarding climate trends. However, the less significant result regarding climate change aspects of rainfall in Mount Elgon in other studies could be because the methods used do not take into account human activities while making predictions [46]. Existing studies

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on climate change percepetions in Mt Elgon however did not focus much on diseases and surveillance/health system. The neigbouring pastoral communities of Karamoja and Teso have similar perceptions of climate change with highly variable rainfall onset/offset and longer and frequent hot periods [47,48]. Meanwhile, elsewhere within East Africa, a study on perceptions regarding climate change in Zanzibar indicated climate change to be occuring with increased rainfall and extreme temperature affecting sea levels and livelihoods [49]. Furthermore, other studies have indicated similar results [50,51]. Climate adapatation plans ought to be designed taking into consideration location perceptions. Notably, local perceptions and interventions should be integrated in the wider climate plans so as to realize optimal impact. In doing so, actions can easily be taken by the community as they already know whats going on and understand first hand the consequences if they don't change their actions. Negotiating such actions can be driven through in a food security lens as communities appear to understand more about climate change from a food security perspective.

Whereas VHTs have been shown to play a fundamental role in health care delivery, they still graple with challenges. In this study, we demonstrated that VHTs have challenges regarding data collection, analysis and dissemination of public health information. Specifically, the VHTs during data collection cannot navigate their localities due to poor infrastructure and inadequate means of transport. They also don't have adequate capacities to store data and relay alerts using their mobile phones. This result is similar to the findings of a study conducted in the semi arid areas of Pader in Northern Uganda where VHTs complained about inadequate transport to reach out to their communities [52]. Other studies have indicated logistical issues in form of transport and communication to be the main challenges hindering VHTs from undertaking ther tasks [53,54]. Other studies have also indicated inadequate trainings to be a challenge faced by VHTs which is similar to what was found in this study [55]. This study revealed inadequate training of VHTs on the signs and synmptoms of common diseases in their locality. The low levels of knowledge regarding data analysis also indicated inadequate trainings regarding such aspects. However, the VHTs may not even have capacities to analyze data because of the challenges with recruitment. Some VHTs are recruited by their peers even when they do not have capacities to undertake disease surveillance tasks. Studies have indicated that recruitment of VHTs is not formal and often undermines their performance [56-59]. No participation of VHTs in reporting of wildlife/animal related disease and environmental events as indicated this study provides an opportunity for diseases to escalate and spillover to humans from livestock and wildlife. There is need to integrate such aspects in the scope of work for the VHTs so as to enhance pandemic preparedness. Other review studies have recommended similar aspects so as attain optimal health of not only humans but also animals minimizing chances of future pandemics [60].

The Integrated Disease Surveillance and Response (IDSR) strategy was adopted by Uganda (from 2010) to adequately manage disease outbreaks, and requires intergation of the community health and One Health aspects so as to achive the intended goals. This strategy will increase contribution to the achievement of the goals of International Health Regulations (IHR, 2005), the Global Health SecurityAgenda (GHSA) and One Health. Implementation of a One Health framework for infectious disease response in Uganda has met with mixed success, having achieved national-level strategic planning and recognition, but challenges with such as intersectoral coordination need strengthened on the ground [61]. The IDSR/IHR committee and the National Task Force on Epidemics (NTF) at the national level, and the

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Emergency Preparedness and Response Committee (EPRC) and the District Task Force (DTF) at district level, constitute the structures responsible for IDSR implementation in Uganda ought to have VHTs on board so as to facilitate relay of their concerns and redress, as well as execute strategic health initiatives at the village level. Integration of this community-level surveillance into the national strategy will facilitate monitoing, prevention and early reporting of disease events.

5. Conclusions

Community based surveillance is very important in preparing for the next pandemic. The Village Health Teams that live closely with the community provide an important avenue for preventing early detection and early response to such public health hazards. They facilitate monitoring of such events allowing for actions to be taken adequately. However, the VHTs need to be retooled so as to respond adequately to public health hazards. This study has indicated how such key stakeholders in surveillance are not adequately equipped to prevent and manage public health hazards. Moreover, the ones assessed are in a highly vulnerable mountain community that has already experienced emerging and reemerging infectious diseases. Furthermore, such key stakeholders should be equipped to report environment changes that are important risk factors for emerging and reemerging infectious diseases. Such aspects can include climate related events and landslides. Relatedly, they need to be champions in emerging environmental conservation so as to minimize environmental degradation. In doing so, impacts of proposed approaches like IDSR will be realized adequately.

Author Contributions: Conceptualization, A.S. and K.C.R.; methodology, A.S. and R.C.K.; formal data analysis, A.S.; investigation, A.S; writing—original draft preparation, A.S; writing -review and editing, R.C.K.; visualization, A.S.; funding acquisition, A.S. and R.C.K. Assisting with field work and review of draft manuscript, R.M. and R.M. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: Approval to conduct this study was obtained from Makerere University college of Veterinary Medicine, Animal Resources and Biosecurity Institutional Review Board (Reference number SBLS.SA.2018).

Informed Consent Statement: Participants gave signed written consent to participate in this study. No participant below 18 years (below adult age) were engaged during this study. Identity of the respondents was kept anonymous, and the district authorities were notified about the assessment.

Data Availability Statement: Data for this survey is available upon reasonable request.

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Conflicts of Interest: We declare no conflict of interest.

Appendix: Questionnaire guide

PART 1: SOCIODEMOGRAPHIC CHARACTERISTICS

Name of your village	
Average herd size (Number of cows)	
Average herd size (number of sheep)	
Average herd size goats	
Average farm size (ha)	

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Level of access to water source point	
Access to electricity	
Number of nearby primary schools	
Number of nearby secondary schools	
Where do you access health services? Traditional healer or western medicine?	

PART 2: SURVEILLANCE CAPACITIES

Ask the respondents about each of the following disease surveillance components. Write 1 for yes and 0 for no

A.	**Collection of data**	
I.	I have a mobile phone for reporting public health events	
II.	I know how to use a mobile phone to report public health events	
III.	I have an emergency number from the ministry of health to report public health threats	
IV.	I have a means of transport to move around my community to collect data on public health	
V.	I have been trained on the signs and symptoms of common infectious diseases	
VI.	I have my record books where I keep data collected	
VII.	I am able to access the nearby health facility	
VIII.	I also report environmental events like flooding, landslides	
IX.	I also report disease events in domestic livestock	
X.	I also report disease events in wild animals	
B.	**Analysis of data**	
I.	I know how to analyze data using bar graphs	
II.	I know how to analyze data using line graphs	
III.	I know how to identify someone with signs and symptoms of a common disease in my community	
C.	**Dissemination**	
I.	I have a venue where I always meet with my community members	
II.	I have stationary (flipchart and markers) to share information with my community members	
III.	I have access to a nearby radio station	

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IV.	I have access to a nearby school	
V.	Because of climatic changes I now farm near stream to irrigate	

PART 3: CLIMATE CHANGE AND PUBLIC HEALTH

Ask the respondents about different aspects of climate and climate change. Relate these with disease outbreaks. Write 1 for yes and 0 for no,

A. Rainfall trends and amounts	
Long rains: there is less quantity of rain now	
Long rains start later	
There are now more dry periods during the rainy season	
Dry season: amount of rain has changed (now more showers)	
Extreme floods: now they come more often	
Hailstones: now they come more often	
Extreme droughts: now they come more often	
B. Temperature trends and levels	
Temperature during the dry season has increased now	
Temperature during the rainy season has increased now	
C. Other climate related events	
Now less number of days with fog during the rainy season	
Now less amount of fog during rainy season	
Now the amount of frost on the ground has decreased	
Now the force of the wind during rainy season has increased	
Now less frequency of hail during the rainy season	
Now less amount of river water during the rainy season	
Now more landslides during the rainy season	
Now more erosion due to more rains	
Now more flooding due to more rains	
D. Climate change and livestock	
Fodder availability in the rainy season has decreased (yes and climatic (1)? Or yes and overgrazing(2)?)	
Fodder quality in the rainy season has decreased (yes and climatic (1)? Or yes and overgrazing(2)?)	
Fodder availability in the dry season has decreased (yes and climatic (1)? Or yes and overgrazing(2)?)	

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Fodder quality in the dry has decreased (yes and climatic (1)? Or yes and overgrazing(2)?)	
Water availability in the dry season has decreased (yes and climatic (1)? Or yes and overgrazing(2)?)	
Water quality in the dry has decreased (yes and climatic (1)? Or yes and overgrazing(2)?)	
Cows produce less milk due to climatic changes	
Cows have more diseases due to climatic changes	
Goats produce less milk due to climatic changes	
Goats have more diseases due to climatic changes	
Sheep produce less milk due to climatic changes	
Sheep have more diseases due to climatic changes	
Maize/Beans have lower yields now due to climatic changes	
Maize/Beans has more pests now	
People are less healthy due to climatic changes	
There are now more animal ticks	
E. Climate change and humans	
Food availability in the rainy season has decreased (yes and climatic (1)? Or yes and human population(2)?)	
Food quality in the rainy season has decreased (yes and climatic (1)? Or yes and human population(2)?)	
Food availability in the dry season has decreased (yes and climatic (1)? Or yes and human population(2)?)	
Food quality in the dry has decreased (yes and climatic (1)? Or yes and human population (2)?)	
Water availability in the dry season has decreased (yes and climatic (1)? Or yes and human population(2)?)	
Water quality in the dry has decreased (yes and climatic (1)? Or yes and human population (2)?)	
We have more human diseases due to climatic changes	
We have new diseases now because of climatic change	

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