ORIGINAL RESEARCH ARTICLE

Knowledge of Obstetric and Neonatal Danger Signs among Community Health Workers in the Rongo Sub-County of Migori County, Kenya: Results of a Community-based Cross-Sectional Survey

DOI: 10.29063/ajrh2020/v24i1.13

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Abstract

In efforts to reduce maternal and neonatal mortality, it is recommended that all pregnant women be counseled on signs of pregnancy related complications and neonatal illness. In resource limited settings, such counselling may be task-shifted to lay health workers. We conducted a community-based cross-sectional survey of community health workers/volunteers in North and East Kamagambo of the Rongo Sub- County of Migori County, Kenya, between January-April 2018. A survey tool was administered through face-to-face interviews to investigate the level of knowledge of obstetric and neonatal danger signs among community health workers in North Kamagambo after one year of participation in the Lwala program, as well as to evaluate baseline knowledge of community health volunteers in East Kamagambo at the beginning of Lwala's expansion and prior to their receiving training from Lwala. The North Kamagambo group identified more danger signs in each category. The percentage of participants with adequate knowledge in the pregnancy, postpartum, and neonatal categories was significantly higher in North Kamagambo than in East Kamagambo. Sixty percent of participants in North Kamagambo knew 3 or more danger signs in 3 or more categories, compared to 24% of participants in East Kamagambo. Location in North Kamagambo (OR 2.526, p=0.03) and a shorter time since most recent training (OR 2.291, p=0.025) were associated with increased knowledge. Our study revealed varying levels of knowledge among two populations of lay health workers. This study highlights the benefit of frequent trainings and placing greater emphasis on identified gaps in knowledge of the labor and postpartum periods. *(Afr J Reprod Health 2020; 24[1]: 121-132).*

Keywords: Community Health Worker, Obstetrics, Neonatal, Danger signs, Kenya, Resource Limited Setting

Résumé

Afin de réduire la mortalité maternelle et néonatale, il est recommandé de conseiller toutes les femmes enceintes sur les signes de complications liées à la grossesse et de la maladie néonatale. Dans les milieux à ressources limitées, ces conseils peuvent être confiés à des agents de santé non professionnels. Nous avons mené une enquête transversale communautaire auprès des agents de santé communautaires / bénévoles dans le nord et l'est de Kamagambo du sous-comté de Rongo du comté de Migori, au Kenya, entre janvier et avril 2018. Un outil d'enquête a été administré par le biais des entretiens face à face pour enquêter sur le niveau de connaissance des signes de danger obstétricaux et néonatals chez les agents de santé communautaire de Kamagambo du Nord après un an de participation au programme Lwala ; ensuite pour évaluer les connaissances de base des volontaires de santé communautaire à Kamagambo de l'Est au début de l'expansion de Lwala et avant de recevoir une formation de Lwala. Le groupe de Kamagambo du Nord a identifié plus de signes de danger dans chaque catégorie. Le pourcentage de participants ayant des connaissances adéquates dans les catégories de la grossesse, du post-partum et du nouveau-né était significativement plus élevé à Kamagambo du Nord qu'à Kamagambo de l'Est. Soixante pour cent des participants à Kamagambo du Nord connaissaient 3

signes de danger ou plus dans 3 catégories ou plus, contre 24% des participants à Kamagambo de l'Est. La localisation à Kamagambo du Nord (OR 2,526, p = 0,03) et un temps plus court depuis la formation la plus récente (OR 2,291, p = 0,025) ont été associés à une connaissance accrue. Notre étude a révélé des niveaux de connaissances variables entre deux populations d'agents de santé non professionnels. Cette étude met en évidence les avantages des formations fréquentes et met davantage l'accent sur les lacunes identifiées dans la connaissance des périodes de travail et du post-partum. *(Afr J Reprod Health 2020; 24[1]: 121-132).*

Mots-clés: Agent de santé communautaire, obstétrique, néonatal, signes de danger, Kenya, ressource limitée

Introduction

Over the last decade, significant advances have been made in reducing the global burden of maternal and newborn mortality, yet rates remain high with approximately 830 women dying per day, as of the end of 2015, due to complications of pregnancy and childbirth[1,2]. Reducing these rates further is a primary focus of World Health Organization (WHO) initiatives and the Sustainable Development Goals (SDG), which have targeted a reduction in the global maternal mortality ratio (MMR) from 216 per 100,000 live births in 2015 to less than 70 per 100,000 live births by 2030[1].

Resource-limited countries continue to bear a disproportionally high burden of global maternal mortality such that, as of 2015, women in these countries had a 33-fold higher risk of death during childbirth than women in developed countries. Fully 99% of all maternal deaths in 2015 occurred in developing countries, with approximately half of those occurring in sub-Saharan African countries[2,3].

Kenya is one of those sub-Saharan African countries for example, whose efforts to date have resulted in reductions in MMR from a reported 759 deaths per 100,000 live births in 2000 to 510 deaths per 100,000 live births in 2015. However, these gains are not equally distributed. Just 15 counties (out of 47) contribute to 98% of all maternal deaths in Kenya[4]. Much progress is still clearly needed if Kenya is to meet the goal of less than 70 deaths per 100,000 live births by 2030[2]. In countries such as Kenya, the majority of maternal deaths occur as a result of direct obstetric complications, including hemorrhage, hypertension, and sepsis[5]. While the occurrence of these complications is difficult to predict, their associated mortality can be prevented with prompt medical care[6]. To this end, the WHO has recommended that all pregnant women be counselled on the danger signs related to these causes of mortality, with hopes that if women are more educated about potential complications, they will present to skilled care sooner should a problem arise[7].

In many resource-limited settings, tasks such as the provision of counselling and active screening for danger signs, are shifted to community health workers (CHWs), lay health workers who may be monetarily compensated or serving in a voluntary capacity[8]. CHWs are members of the community who lack formal education in healthcare but have been trained to provide some level of basic health services to their peers, often acting as liaisons between the community at large and the healthcare system. Programs that rely on CHWs have been shown to improve maternal utilization of health services and reduce child and neonatal mortality, but quality amongst CHW programs vary[9–15]. Despite initiatives designed to ensure that pregnant women know when to present for care, many studies throughout Africa and Asia have shown that a lack of knowledge regarding obstetric and neonatal danger signs among pregnant women remains common[16,17].

On the other hand, CHW knowledge has been shown to be extremely variable across different countries and regions and is partially dependent on the training and supervision that they themselves receive. Inadequate training can be a common problem, and in some cases CHWs are expected to perform tasks for which they have never been trained, or they are offered only on-the-job training, with no dedicated, formal instruction[18,19].

The Lwala Community Alliance (Lwala) is a community-led, multifaceted organization in rural western Kenya serving a community of ~30,000 persons as of the study period, with the goal of advancing the community's own comprehensive wellbeing. Founded in 2007,

Lwala operates a hospital and clinic with inpatient, outpatient, maternal, and HIV care, as well as an innovative CHW program incorporating traditional birth attendants, and supports government health facilities to improve the quality of maternal and child health services. During the study period, Lwala operated in North Kamagambo, one of four wards within the Rongo Sub-county of Migori County. Its 3-year plan includes expanding its catchment area to progressively incorporate all wards of the Rongo sub-county, with expansion into East Kamagambo beginning in 2018, followed by South and then Central Kamagambo by the end of 2020 (Figure 1).

Lwala's CHWs receive an intensive initial training course as well as regular refresher trainings. The initial training course is designed as a 10-day training program, with 8 days of classroom didactics and two days of practicum activities. In addition to information on maternal and child health, water sanitation and hygiene (WASH), malaria, family planning, HIV/AIDS, non-communicable diseases, basic first aid, and communication; interpersonal skills are also taught. Lwala requires that CHWs complete refresher training at least every 6 months. For their effort, Lwala provides its CHWs with monthly supervision visits and support, as well as a monetary stipend.

Up to the time of this report, Lwala only supported CHWs operating in North Kamagambo, but plans to expand its program in-line with Ministry of Health (MOH) objectives and in direct partnership with MOH officials to three additional locations in East, Central, and South Kamagambo. These locations currently have government-trained Community Health Volunteers (CHVs). In contrast to Lwala CHWs, some current CHVs in these expansion areas received an initial training course, but participated in fewer refresher trainings over time, have less frequent supervision, and do not receive monthly stipends. Other than these aspects, CHW´s and CHV´s are considered by the MOH to provide a similar level of care, based on the fact they are recruited from the existing community pool of lay personnel and the community health responsibilities asked of them are the same. A unique aspect to the Lwala CHW program is that they intentionally target all active traditional birth attendants (TBAs) in a given area (regardless of literacy or education level) and recruits them into their broader CHW program. TBAs currently assist about half of all deliveries in Kenya, yet typically are not part of the formal health system and do not participate in many of the MOH community-based initiatives. The Lwala CHW program hypothesizes that bringing this cadre of informal health worker into its program builds on traditional knowledge and skills that are trusted by the community. TBAs bridge an important gap in linking populations that have not traditionally accessed the formal health system. Furthermore, by actively engaging TBA's they become partners to positive community change rather than competition.

The Migori County MOH is aligned with national priorities to provide universal health coverage, with investments in community health being a key pillar. The MOH has made steps towards increased support of these community health agents, and quality initiatives, like Lwala's CHW model, is an important experiment to inform the development of future community health programming.

This study sought to investigate the level of knowledge of obstetric and neonatal danger signs among CHWs in North Kamagambo after one year of participation in the Lwala CHW program, as well as to evaluate baseline knowledge of CHVs in East Kamagambo at the beginning of Lwala's expansion and prior to their receiving training from Lwala. In addition, we sought to evaluate potential determinants, or predictors, of CHW/CHV knowledge level, in order to inform ways in which we might alter future trainings for better learning, as well as the development of other CHW/CHV implemented interventions designed for improving the care provided by CHW/CHVs in Rongo Sub-County.

Methods

Study area

This study was conducted in North and East Kamagambo of the Rongo Sub- County of Migori County, Kenya. Both locations are rural settings with inhabitants who rely primarily on subsistence

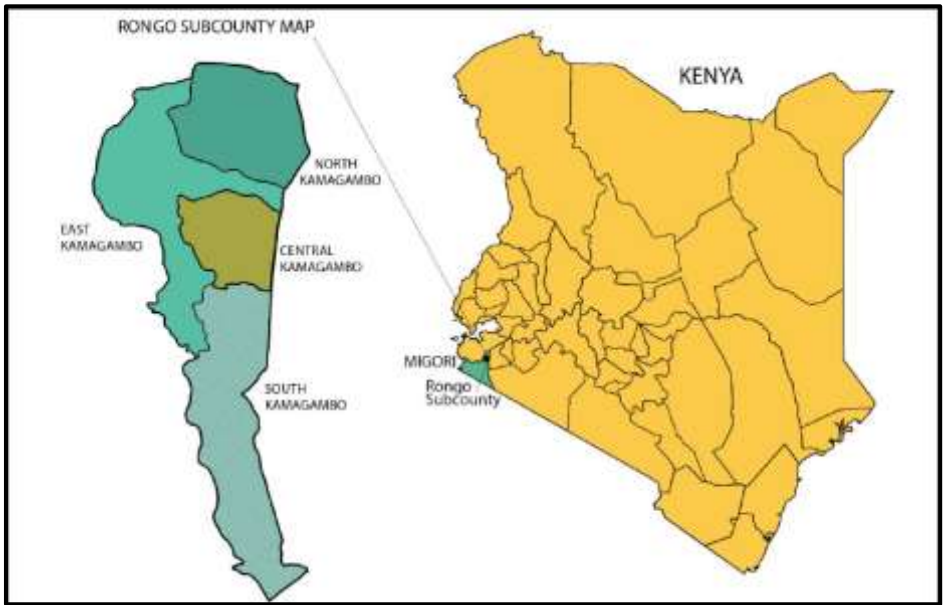

Figure 1: Map of Migori County, Kenya showing the location and divisions of Rongo Sub-County

Table 1: Danger Signs of the Pregnancy, Labor, Postpartum, and Neonatal Periods

Pregnancy	Bleeding, fever, convulsions, severe abdominal pain, severe weakness, headache, swollen hands, blurred vision, difficulty breathing, premature rupture of membranes, decreased fetal movement, loss of consciousness
Labor	Bleeding, prolonged labor, headache, convulsions, retained placenta, fever, loss of consciousness
Postpartum	Bleeding, malodorous discharge, fever, severe weakness, headache, convulsions, blurred vision, swollen hands, face, difficulty breathing
Neonatal	Poor sucking or feeding, low birth weight, fever, difficult or fast breathing, rigidity or convulsions, erythema or pus around umbilical cord, red or swollen eyes, yellow skin or eyes, skin lesions or rash

farming. The primary ethnic group in the region is Luo.

Study design

We conducted a community-based cross-sectional survey of CHW/CHVs between January-April 2018. The survey tool was modeled after the JHPIEGO guide titled: Monitoring birth preparedness and complication readiness, with additional questions included from the peer-reviewed literature[20,21]. The instrument is extensive and is intended to be used to evaluate multiple levels of health care systems including individual patients, trained healthcare providers, and health centers. For this small study we utilized one of the many surveys included in this instrument intended to assess patient knowledge of obstetric danger signs.

Sample size and sampling procedure

At the time of survey, there were 83 CHWs working in North Kamagambo and 90 CHVs working in East Kamagambo. We used a limited sample size calculation for an ordinal regression. This approach allows us to estimate the number of allowable degrees of freedom in order to refrain from over fitting our model. Our goal was to have a response rate of 95%. Participants were approached and recruited at routinely scheduled monthly CHW/CHV meetings.

Data collection tool and procedure

After obtaining informed consent, the survey tool was administered through face-to-face interviews. The survey tool consisted of three main sections evaluating socioeconomic characteristics,

knowledge of obstetric and neonatal danger signs, and client counselling practices. The survey questions were read in the language of the participant's choosing, either English or Dholuo. The participant's answers were recorded by the interviewer. Completing the survey took approximately 15-20 minutes per interview. After answering demographic questions, participants were asked in an open-ended manner to name the danger signs of the pregnancy, labor, postpartum, and neonatal periods. As the participant named danger signs, the interviewer selected the named signs from a list not available to the participant. In cases where the participant named a danger sign not coded by our survey, their answer was recorded as quoted text.

Two trained interpreters, who were not previously associated with any CHW program, were contracted to administer the interviews in Dholuo. The interpreters were recommended to the researcher by local Lwala staff due to their excellent knowledge of both English and Dholou. Prior to conducting the interviews, the interpreters translated the survey into Dholuo and then back into English to ensure correct meaning was retained. Interviews were conducted at regularly scheduled meetings of CHW/CHVs, which occurred at health facilities, churches, and schools. The researcher administered the survey in English when English was the participant's preferred language. If Dholuo was the participant's preferred language, then the researcher administered the questionnaire in English and the interpreter translated the questions and response. A private location at each of the facilities was ensured so that participants would not be overheard during the informed consent process or while giving their answers. Each participant was given 200 Kenyan Shillings (approximately 2 USD) to cover the cost of transportation from the participant's home to the interview location.

Definitions

Danger signs were broadly divided into obstetric and neonatal themes with obstetric danger signs further disaggregated into three categories (pregnancy, labor, and post-partum) (Table 1)[20]. For the purpose of this analysis, both CHWs and CHVs will be referred to more broadly as CHWs going forward.

Though trained on identifying all the above listed danger signs, Lwala expects that its CHWs will counsel their clients on a minimum of three of the different danger signs in each of the above categories. For this reason, CHWs were considered knowledgeable in a given category if they were able to name three or more danger signs for that category. This definition of "knowledgeable" has been used in other previously published studies[16,21].

Data management and analysis

Data was entered in real-time using REDCap electronic data capture tools hosted at Vanderbilt University Medical Center[22]. This software prompted the researchers when required information was not entered, ensuring that surveys were conducted and recorded in entirety. Descriptive statistics and ordinal regression analysis was performed using RStudio (version 3.4.3) and Frank Harrell's "Hmisc" and "rms" packages[23]. To test the association between independent variables and the dependent variable, an ordinal logistic regression was used. In addition, restricted cubic splines with three knots were used on the continuous variables to help fit the model. Since education, time since training, and years of experience did not meet the ordinality assumption; a continuation ratio model was fitted. Partial residual plots were used to determine if this model met ordinality at assumption.

Because the residual plots resulting from the continuation ratio model did not show parallelism and the ordinal logistic regression model is robust, we decided to use the ordinal logistic regression model.

Ethics approval and consent to participate

Ethical approvals for this study were obtained from the AMREF Health Africa Ethics and Scientific Review Committee and the Vanderbilt University Institutional Review Board. Information about the study was given verbally in the participant's preferred language. Written informed consent was obtained. Informed consent documents were kept in a secure location. All

recruitment, consent, and interviews were done in accordance with the approved protocol.

Results

Demographic characteristics

A total of 148 CHWs were interviewed, 80 in North Kamagambo and 68 in East Kamagambo, representing 96% of CHWs operating in North Kamagambo and 76% of CHWs operating in East Kamagambo (Table 2). The average age and education levels between the two groups did not vary. In North Kamagambo, 100% of CHWs had received training related to obstetric and neonatal danger signs, with a median 6 months [interquartile range (IQR): 5-7] since their last training on this topic. In East Kamagambo, 78% of participants had received training on obstetric and neonatal danger signs, with a median 12 months [IQR: 8-24] since their last training on this topic. A greater number of years of experience working as a CHW, on average, was found in the North Kamagambo group, with a median of 6 years compared with only 4 years in East Kamagambo.

Assessment of obstetric and neonatal knowledge

Overall, both groups were able to identify the most danger signs associated with the pregnancy period, followed next by the neonatal period, then post-partum, and with the least number of danger signs identified being associated with labor and delivery (Table 3). We next analyzed the number of categories for which each participant was considered knowledgeable (being able to identify three or more danger signs within the category). Ninety-seven percent (97%) of CHWs in North Kamagambo were able to identify three or more danger signs about the pregnancy period compared to only 51% of CHW's in East Kamagambo ($p<0.01$). The North Kamagambo CHWs were also more knowledgeable in the neonatal category, where 82% of participants were considered knowledgeable as compared to only 50% in East Kamagambo ($p<0.01$). Rates of knowledge of danger signs in the postpartum period was relatively low in the North Kamagambo group at 60%, but even lower in East Kamagambo at 27% ($p<0.01$). There was no significant difference between groups' knowledge of the labor period (Figure 2). Overall, 24% of CHWs in East Kamagambo did not meet the criteria for being knowledgeable in any of the four categories, compared to 8% of CHWs in North Kamagambo. Only 23 CHWs in the study were considered knowledgeable in all four categories of danger signs, making up 19% of North Kamagambo CHWs and 12% of East Kamagambo CHWs (Figure 3).

Factors associated with increased knowledge about obstetric and neonatal danger signs

Logistic regression was used to determine factors associated with increased CHW knowledge. Because few participants were knowledgeable in three or more categories of danger signs, we limited the primary endpoint for this analysis to identifying greater than three danger signs in both the pregnancy and neonatal periods. Location in North Kamagambo was associated with increased odds of being knowledgeable in the pregnancy and neonatal periods, after adjusting for experience, length of time since last trainings, and education.

Counseling by CHWs

Nearly all participants surveyed (98%) identified the health facility as the safest place for a woman to give birth, regardless of whether they were located in North or East Kamagambo. Likewise, 98% of participants recommended that their clients go immediately to the nearest health facility should they or their child begin to experience a danger sign. Ninety-seven percent of participants believed that the CHW should provide education at every home visit. All of the participants who named an alternative location for the safest place to give birth (2%), an alternative action for if the client was experiencing a danger sign (2%) or believed education on dangers signs should be provided less frequently (2%) were located in East Kamagambo.

Table 2: Demographic characteristics of community health workers in North and East Kamagambo, Migori County, Kenya: January-April 2018

	North Kamagambo n=80 (%)	**East Kamagambo n=68 (%)**	**p-value**
Age [median, IQR]	40 [35-47.2]	40 [34-47]	0.5551
Experience in years as a CHW [median, IQR]	6 [5-9]	4 [3-6]	<0.0011
Ever had training	80 (100%)	53 (78%)	<0.0012
Time in months since last training [median, IQR]	6 [5-7]	12 [8-24]	<0.0011
Education			0.1762
≤ Grade 4	9 (11.2%)	6 (8.8%)	
Grade 5-8	35 (43.8%)	21 (30.9%)	
≥ Grade 9	36 (45.0%)	41 (60.3%)	

IQR= interquartile range
Tests used: [1]Wilcoxon test, [2]Pearson chi-square analysis

Table 3: Danger Signs Identified

	North Kamagambo n (%)	**East Kamagambo n (%)**	**Total n (%)**
Pregnancy			
Bleeding	64 (80)	34 (50)	98 (66)
Fever	52 (65)	29 (43)	81 (55)
Convulsions	45 (56)	11 (16)	56 (38)
Severe abdominal pain	39 (49)	20 (29)	59 (40)
Severe weakness	36 (45)	13 (19)	49 (33)
Headache	34 (43)	22 (32)	56 (38)
Swollen hands, face	29 (36)	13 (19)	42 (28)
Water breaks without labor	26 (33)	8 (12)	34 (23)
Blurred vision	19 (24)	5 (7)	24 (16)
Difficulty breathing	8 (10)	4 (6)	12 (8)
Decreased fetal movement	8 (10)	4 (6)	12 (8)
Loss of consciousness	4 (5)	4 (6)	8 (5)
Average number identified	5	2.7	3.9
Labor			
Bleeding	57 (71)	39 (57)	96 (65)
Prolonged labor	45 (56)	18 (26)	63 (43)
Headache	17 (21)	12 (18)	29 (20)
Convulsions	12 (15)	3 (4)	15 (10)
Fever	9 (11)	11 (16)	20 (14)
Placenta not delivered	6 (8)	12 (18)	18 (12)
Loss of consciousness	5 (6)	7 (10)	12 (8)
Average number identified	1.9	1.5	1.7
Postpartum			
Bleeding	67 (84)	39 (57)	106 (72)
Severe weakness	48 (60)	30 (44)	78 (53)
Headache	32 (40)	17 (25)	49 (33)
Fever	29 (36)	16 (24)	45 (30)
Convulsions	26 (33)	7 (10)	33 (22)
Blurred vision	14 (18)	7 (10)	21 (14)
Swollen hands, face	10 (13)	6 (9)	16 (11)
Malodorous discharge	6 (8)	7 (10)	13 (9)
Difficulty breathing	2 (3)	6 (9)	8 (5)
Average number identified	2.9	2	2.5
Neonatal			
Poor sucking or feeding	57 (71)	42 (62)	99 (67)
Infected umbilical cord	51 (64)	32 (47)	83 (56)
Difficult or fast breathing	37 (46)	32 (47)	69 (46)
Fever	35 (44)	8 (12)	43 (29)
Rigidity or convulsions	31 (39)	8 (12)	39 (26)
Red, swollen eyes	28 (35)	3 (4)	31 (21)
Low birth weight baby	18 (23)	15 (22)	33 (22)
Yellow skin or eyes	9 (11)	14 (21)	23 (16)
Skin lesions, rash, blisters	8 (10)	8 (12)	16 (11)
Average number identified	3.7	2.5	3.2

*Respondents could choose more than one response. Therefore, the percentages may add up to more than 100%

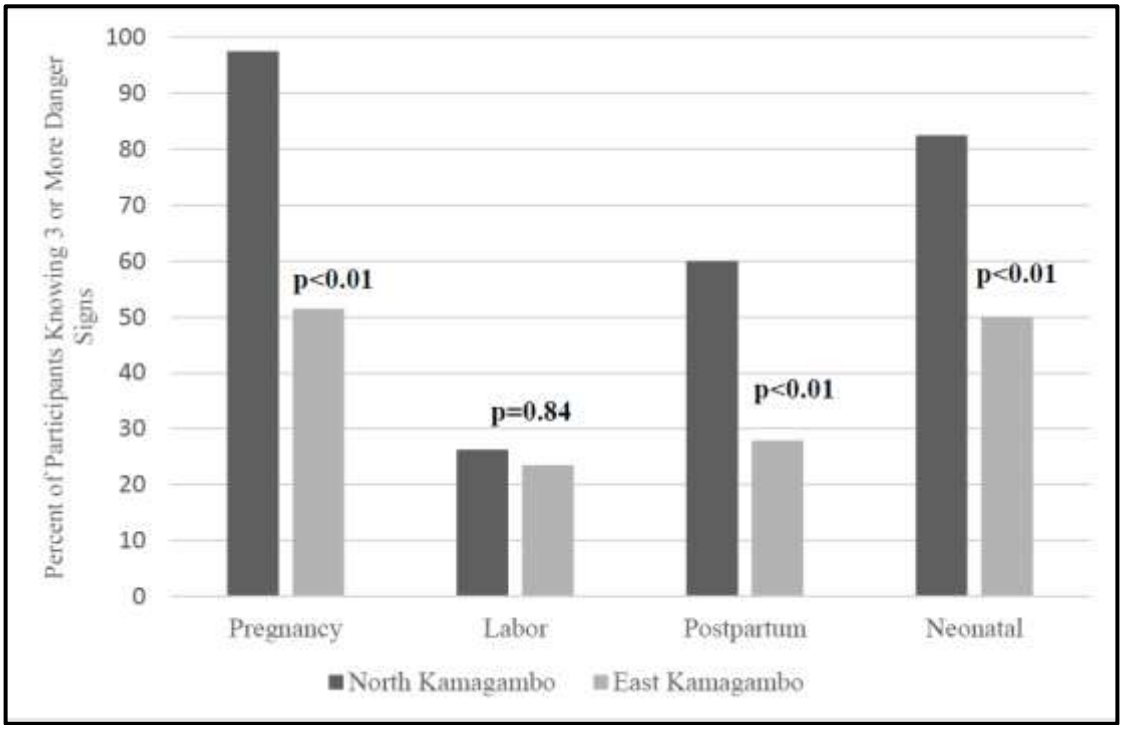

Figure 2: Percentage of participants knowledgeable in categories of danger signs

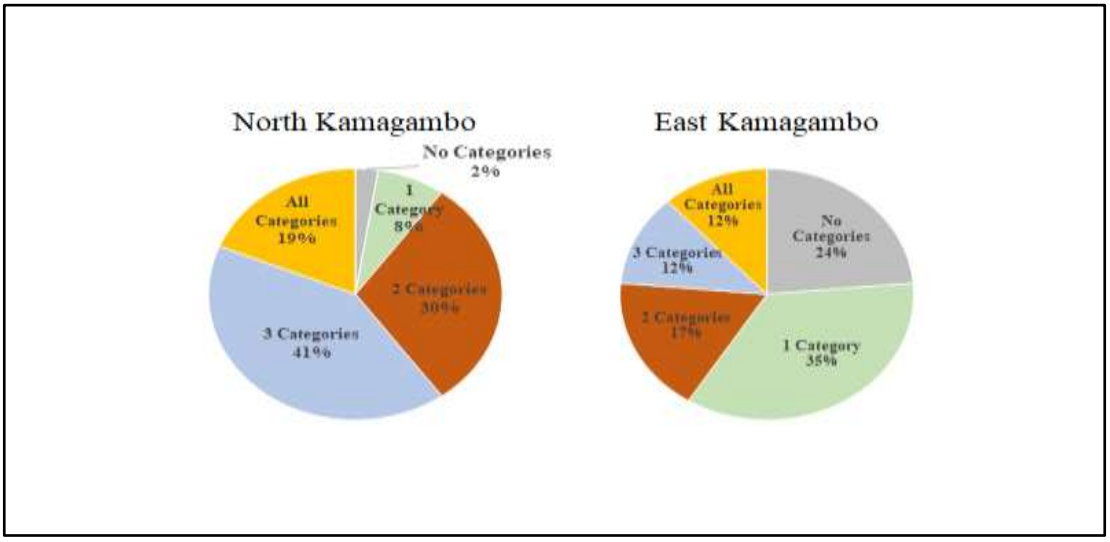

Figure 3: Percentage of participants knowledgeable in greater than 1 category of danger sign

Table 4: Factors associated with increased CHW knowledge of pregnancy and neonatal danger signs

	aOR	95% CI	P-value
North Kamagambo	5.678	(2.576, 12.517)	<0.001
Education (≤ Grade 4)	0.887	(0.300, 2.624)	0.829
Education (≥ Grade 9)	1.103	(0.549, 2.216)	0.693
Experience	1,420	(0.926, 2.180)	0.114
Time since last training (per 1-month decrease)	0.771	(0.444, 1.337)	0.411

Discussion

Women's knowledge of danger signs during pregnancy is in part dependent on the quality of counselling and health education that she receives; increased CHW knowledge has been correlated with increased maternal knowledge[9,24]. Ideally, the person providing this counselling should have a high level of knowledge regarding obstetric and neonatal danger signs.

CHWs in North Kamagambo were more knowledgeable about danger signs during the pregnancy and neonatal periods than their counterparts in East Kamagambo. However, both groups showed lower knowledge about danger signs during labor and the post-partum period, both of which contain a high risk of maternal mortality. Factors such as education level and years of experience as a CHW were not predictive of increased knowledge. The only factor significantly associated with increased knowledge was the CHW's location in North Kamagambo.

This study adds to the growing literature on CHW knowledge about obstetric and neonatal danger signs, which has been previously reported with varying results. For example, one study in Ethiopia found that 88% of health extension workers had poor knowledge, identifying an urgent need to improve training[25]. Studies in other locations, however, have found adequate knowledge amongst participating CHWs[26,27]. A study in Uganda, for example, showed that 88% of participants knew greater than three danger signs associated with the neonatal period; another showed that 74% of health workers could name five neonatal danger signs[27,28]. Our study shows similar variation in knowledge, even among lay health workers in two locations very close to one another. This variation is likely dependent on the location-specific recruitment, training, compensation, and supervision of local CHWs.

Our study demonstrated low knowledge of the labor and postpartum periods, which may be in part related to local lay health worker protocols. The CHWs are taught to refer all laboring women immediately to the health facility for skilled care, without waiting for danger signs of labor complications to occur. Our study tested for knowledge about these complications of labor, but not signs of normal labor which likely would have yielded better knowledge scores. Low knowledge of the postpartum period, however, is a greater area of opportunity, as the risk of maternal mortality remains elevated long after delivery and discharge from a health facility[6]. In Kenya, women are routinely discharged from the health facility 24 hours after giving birth, with the assumption that a CHW will provide postpartum evaluations; therefore adequate CHW knowledge of the complications that may arise in the dangerous postpartum period is essential. An overwhelming majority of CHWs reported the health facility as the safest place to give birth and knew to refer their clients to the health facility immediately should a complication arise. The education promoting the health facility as a source of quality healthcare has been successful. Our study suggests that CHW knowledge deficits lie not in knowing what to do if a complication occurs, but rather how to recognize such complications. Future trainings in the region should stress the danger signs that can arise in the postpartum period and the importance of screening for danger signs in the mother as well as the neonate.

Interestingly, this study did not show an association between education or years of experience and increased knowledge of danger signs, however CHWs in North Kamagambo were more likely to be knowledgeable on danger signs of the pregnancy and neonatal periods than their East Kamagambo counterparts. This suggests that elements of the Lwala CHW program already initiated in North Kamagambo, including frequent refresher trainings and more frequent supervision, are effective in increasing lay health worker knowledge. In previous studies, increased supervision of lay health workers has been associated with increased knowledge of obstetric danger signs[29]. The CHWs in North Kamagambo engage in weekly small group meetings with their primary supervisor and monthly program-wide meetings with representatives from the health facility. For their efforts, they also receive monetary compensation well above the regional average for other CHVs. At the time of this study, most CHVs in East Kamagambo, on the other hand, worked on a volunteer basis without consistent compensation. It is expected, based on

our findings that increased supervision and compensation resulting from being incorporated into the Lwala CHW program may lead those workers in North Kamagambo to have a greater sense of engagement in their learning and knowledge, reflected in better knowledge scores. It is also expected that knowledge of the labor and postpartum danger signs would increase in both regions if a greater emphasis was placed on these topics during refresher trainings. We propose adapting current training modules based on the weaknesses identified in this survey.

This study has several important limitations to consider. This is a cross-sectional survey capturing knowledge only at one time point and may not be the most accurate way of assessing CHW knowledge. It is possible that CHWs recognize danger signs in the field without being able to name them for our survey. Additionally, while we may predict that mothers in the North Kamagambo region are more knowledgeable than those in East Kamagambo, as a result of contact with more knowledgeable CHWs, we are unable to conclude this based on the results of this study alone. Finally, our results suggest that the Lwala CHW model is strongly associated with increased knowledge, but our study was not designed to investigate the specific parts of the model that are most effective. Future studies should aim to identify the most effective pieces of the Lwala model so that other sites may incorporate them with similar results.

Despite the limitations, this study has several strengths. First, this is an assessment of CHW knowledge conducted in an area in which no similar studies have previously been conducted. We mitigated some limitations by using previously published and validated tools for assessing health worker knowledge. Finally, while other studies have focused on specific aspects of prenatal or neonatal care, our study investigated multiple aspects of antenatal care, ranging from the pregnancy period through the postpartum and neonatal periods.

Conclusion

Our study demonstrates varying knowledge across two unique populations of CHWs. We identified gaps in CHW knowledge, particularly in the labor and postpartum areas. Our results suggest that the Lwala model of CHW engagement in North Kamagambo is associated with increased knowledge. We recommend continuing frequent refresher trainings while placing greater emphasis on the areas of weakness identified by this study. Ideally, a system of internal evaluation would provide regular feedback on CHW performance, allowing for refresher trainings to be continuously adjusted to address gaps in knowledge. Future studies may investigate other specific aspects of the Lwala program—such as their leadership model, recruitment of traditional birth attendants, compensation structure, or organizational philosophy—that may encourage increased CHW engagement in training sessions and, in turn, increased CHW knowledge.

Acknowledgements

The authors thank Verine Achieng, Felix Omondi, and Malachy Obunga, whose translation efforts made this study possible. Thanks also to Ayesha Agarwal and Nicole Phillip, who were of great help in getting the project off of the ground.

Contribution of Authors

SH, JM, AR, DR, MD and TM were involved in the design of the study. SH, BO, and MW were involved in data collection. SH, CH, MD and TM were involved in data analysis. SH, CH, BO, MW, JM, AR, DR, MD, and TM were involved in preparation and edits of the manuscript. All authors approve of the manuscript.

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