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Access and utilization of water and sanitation facilities and their determinants among pastoralists in the rural areas of northern Tanzania

ELIAS C. NYANZA[1,2], OLA JAHANPOUR[1*], JENNIFER HATFIELD[2], FRANK VAN DER MEER[2,3], LISA ALLEN-SCOTT[2], KARIN ORSEL[2,3] and SHERI BASTIEN [2,4]

[1]*School of Public Health, Catholic University of Health and Allied Sciences, P.O. Box 1464, Bugando Area, Mwanza, Tanzania*

[2]*Department of Community Health Sciences, Cumming School of Medicine, University of Calgary, 3280 Hospital Drive NW, Calgary, AB Canada T2N 4Z6*

[3]*Department of Ecosystem and Public Health and Department of Production Animal Health, Faculty of Veterinary Medicine, University of Calgary, 3280 Hospital Drive NW, Calgary, AB Canada T2N 4Z6*

[4]*Department of Public Health Science, Norwegian University of Life Sciences, Universitetstunet 3, 1433 Ås, Norway*

Abstract

Background Lack of safe water, sanitation and hygiene remains one of the most pressing global health issues of our time. Water and sanitation-related improvements are crucial in meeting the Global Sustainable Development Goals. This study was conducted to determine the access, utilization and determinants of access to sanitation facilities among pastoral communities in rural areas of northern Tanzania.

Methods: This cross-sectional study was carried out in Ngorongoro Conservation Area of Ngorongoro District in northern Tanzania. The survey included key measures adapted from the Joint WHO/UNICEF Core Questions on drinking-water and sanitation for Household Surveys. An observation checklist was also completed at each household. Geographical positions of the households were recorded using a Global Positioning System.

Results: A total of 175 households participated in the study. More than half (61.7%, n=108) of the participants reported access to an improved water source throughout the year. The majority (50.3%, n=88) of the households reportedly practised open defecation. The multivariate analysis identified that the key determinants to access a sanitation facility at a household were socio-economic status, family size, presence of under-five years of age in the household, history of diarrhoeal diseases, having ever received education on sanitation and motivation for improvement in defecation place.

Conclusion: There is limited access to water and sanitation facilities in communities in the Ngorongoro Conservation Area. Individual and community factors are key determinants for a household to own a sanitation facility. Findings from this study indicate a need for interventions to improve access to water, and sanitation facilities in the area.

Keywords: access, water, sanitation, hygiene, pastoralists, Tanzania

Introduction

Poor water, sanitation and hygiene (WASH) status is associated with a range of intestinal, ophthalmic, skin and respiratory infections (Aiello & Larson 2002; Rabie & Curtis 2006; Bartram *et al.*, 2014). Poor WASH status has also been associated with morbidities and mortalities particularly for children under five years of age (Bartram *et al.*, 2014). The majority of these deaths result from diarrhoeal diseases, but also from other diseases such as pneumonia (Bartram *et al.*, 2014; Thomas *et al.*, 2013). Individuals affected by diseases associated with poor WASH conditions predominantly live in sub-Saharan Africa (Thomas *et al.*, 2013; Bartram *et al.*, 2014; Hutton & Chase, 2016). The burden of poor sanitation and hygiene, however, goes beyond health-related issues (Hutton & Chase, 2016). Poor sanitation and hygiene may lead to school and workplace absenteeism, which in turn may impact academic achievement and workplace performance. These impacts affect not just the individual, but also the community and wider society, with respect to economic and overall development (Hutton & Chase, 2016) .

* Correspondence E-mail: ola.jahanpour@gmail.com

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There has been an overall improvement in the accessibility of water and sanitation facilities at a global level. This led the World Health Organization (WHO) to conclude that the Millennium Development Goal (MDG) 7, which had a target of reducing the population without access to safe drinking water by 50%, had been met (UNICEF/WHO, 2015). While the set target for improved sanitation status was not reached, the use of improved sanitation facilities has increased from 54% in 1990 to 68% in 2015 (UNICEF/WHO, 2015). Even with these achievements, efforts to improve WASH status is still an unfinished agenda, which is recognized in the recently ratified Sustainable Development Goals (SDGs) whereby its goal 6 is to "Ensure availability and sustainable management of water and sanitation for all" (Gine-Garriga *et al.*, 2015). It should be noted that despite improvements that have been achieved, regional disparities and differences in accessibility have been reported (Hutton & Chase, 2016).

Rural areas have been found to have poorer sanitation and hygiene practices than urban areas (Stephen & Graham, 2014; Thomas *et al.*, 2016). In Tanzania, only 13% of households have improved sanitation facilities (WHO/UNICEF, 2006), the majority of which are in urban settings (TDHS, 2011). Among the rural areas in northern Tanzania, poor sanitation has been observed to be on the rise, and overall, among pastoralists and other groups whose main source of livelihood is livestock keeping (Stephen & Graham, 2014).

There is a knowledge gap with respect to the sanitation and hygiene status of pastoral communities in Tanzania, and key determinants of access and utilization of sanitation and hygiene facilities for this population (Stephen & Graham, 2014; Henderson *et al.*, 2015). The Ngorongoro Conservation Area (NCA), located in rural and remote Tanzania, is predominantly populated with Maasai pastoralists. A review of local hospital records in the NCA in 2014 showed that WASH-related infections such as helminth and protozoa infections are consistently in the top ten diagnoses. In response to this, a school and community-based intervention (Project SHINE – Sanitation and Hygiene INnovation in Education) was developed to improve capacity among youths and the wider community to improve sanitation and hygiene status in the NCA. This intervention aimed at engaging and empowering the Maasai youth and communities to develop culturally appropriate health promotion strategies and to create an enabling environment to support uptake and maintenance of these strategies (Bastien *et al.,* 2015). It was anticipated that in the long-term, these efforts may result in improvements in health, especially, a reduction in the incidence of diarrheal disease. The present study is a component of Project SHINE which aimed to determine access, utilization and determinants of access to sanitation facilities among the Maasai pastoralist communities in NCA in northern Tanzania.

Materials and Methods

Study setting, design and population

A cross-sectional study was carried out among the Maasai communities in Ngorongoro Conservation Area (NCA) in northern Tanzania during May and June of 2014 and 2015. Endulen and Nainokanoka wards were selected to participate in the study based on their participation in the Project SHINE intervention. These wards also represent villages for the pastoral communities with semi-permanent settlements. These wards have a population of 14,630 and 15,613 respectively (URT, 2013). Endulen ward has more infrastructure compared to Nainokanoka ward, with a hospital and greater access to social services. All eight villages from these two wards (four from each ward) were included in the study. Maasai communities live in a clanship polygamy, where most of the family and/or clan members live very closely in a locus-like mode forming one big household also called *bomas* (Galvin et al., 2004). Heads of households provided information on socio-demographic characteristics and history of diseases of the whole household and also information on the sanitation and water accessibility of the household.

All households with a consenting member of the household of at least 18 years of age were eligible to participate in the study. There was a total of 4,520 households in the three

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selected villages (URT, 2013). A convenience sampling strategy was used to select 175 households.

Data collection

Face to face interviews were carried out with the heads of the households and an observation checklist was used to evaluate the sanitation facilities. To ensure uniformity in reporting the evaluations, the data collection instruments were piloted using local translators and researchers in villages not participating in the study. A questionnaire was used to collect data on demographic and socio-economic characteristics, accessibility to, and utilization of water and sanitation facilities. The head of the household was also asked questions that probed history of diarrhoeal diseases in the family in the previous six months. Other questions related to materials used to construct a sanitation facility, to assess the determinants of owning a sanitation facility.

The eight variables collected as part of the demographic questionnaire were collated to form a total score of 2 to 3 for each of the following variables: a) house type, b) roofing of the house, c) ownership of a car, d) ownership of a motorcycle, e) ownership of a bicycle, f) access to electricity, g) ownership of a cell phone, and h) ownership of a radio. Responses to each of these questions were summed, and scores of 0 to 4 classified are considered as low socio-economic status (SES), 5 to 8 as moderate SES, and more than 9 a high SES.

Water accessibility was assessed by asking participants to identify the main source of water for the household during the wet and dry season. These sources were then categorized into improved or unimproved (WHO/UNICEF, 2006). In this category, improved water sources included piped water supply into the dwelling, a protected dug well, a protected spring and rainwater. Unimproved water sources included unprotected dug well, unprotected spring, a cart with a small tank/ drum, a water tanker truck, and surface water. To investigate access to sanitation facilities, participants were asked to indicate their principal defecation place.

Observation checklist

The facilities were visited and categorized into either improved or unimproved, using an observation checklist that used the established categories (WHO/UNICEF, 2006) Utilization of sanitation facilities was evaluated by conducting an observation of the facility, the cleanliness of the floor, the presence of a lid and the presence of faecal matter outside the facility.

Mapping of Sanitation Facilities

The respective coordinates of surveyed households were recorded using a global positioning system (GPS) receiver. Maps were produced using ArcGIS 9.2 software (ESRI, 2010). Base maps were obtained from the Tanzanian Land Survey Department (TLSD, 1994). The contoured sanitation maps were created by kriging using Surfer 9 software (Golden Software Inc, 2010). Other household characteristics captured such as accessibility of a sanitation facility from the questionnaire and checklist were incorporated on the maps.

Ethical considerations

Ethical approval was obtained from the Catholic University of Health and Allied Sciences and Bugando Medical Centre joint Research and Ethics Review Committee in Tanzania, the University of Calgary Conjoint Health Research Ethics Board (CHREB) in Canada (REB14-0202_REN2) and the Medical Research Coordinating Committee of the Tanzania National Institute for Medical Research. Permission to conduct research in the Ngorongoro District was obtained from the respective authorities at the regional, district and village levels. A written informed consent was obtained from the head or representative of the household witnessed by their local leader. To ensure anonymity, the location of specific households has been aggregated and corresponding coordinates are not included.

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Data analysis

Data were analysed using STATA version 13. Descriptive statistics were used to summarize the data. The Odds ratio (OR) and their 95% confidence intervals (CI) were used to assess the strength of associations between several variables and access to a sanitation facility (improved and unimproved). All the predictor variables with *P-value* of < 0.05 in the bi-variate analysis were included in the regression model. *P-values* of <0.05% were considered significant.

Results

Socio-demographic characteristics of the participants

All 175 households invited to participate, consented to take part in the study (Table 1). There were 56.6% (n=99) females and 43.4% (n=76) males. Most households had between 5 and 10 members 42.6% (n=74), with a median size of 7 (IQR 4, 12). Most of the households (58.3%; n=102) had 1- 4 children under-five years of age, with a mean of 2.73 (SD ± 3.3). The socioeconomic status of the majority of the population was moderate 50.9% (n=89), while 35.4% (n=62) and 13.7% (n=24) had low and high socio-economic status, respectively.

Availability of sanitation facilities

The most commonly reported place for defecation was in the open 50.3% (n=88), often referred to as open defecation (shown as no facility on the map) and with 10.9% (n=19) using an improved sanitation facility and the remaining 38.8% (n=68) with an unimproved sanitation facility (Figure 1). Despite the different household sizes, many reported that they had only one sanitation facility 46.3% (n=81). The majority of households with a sanitation facility reported that obtained construction materials for the sanitation facility from Karatu, a township in the nearby district, at approximately 70km distance 75% (n=66/88). The next most common source of material was from nearby bushes and forest 21.6% (n=19/88) while the rest 2.3% (n=2/88) reported to get them from Endulen.

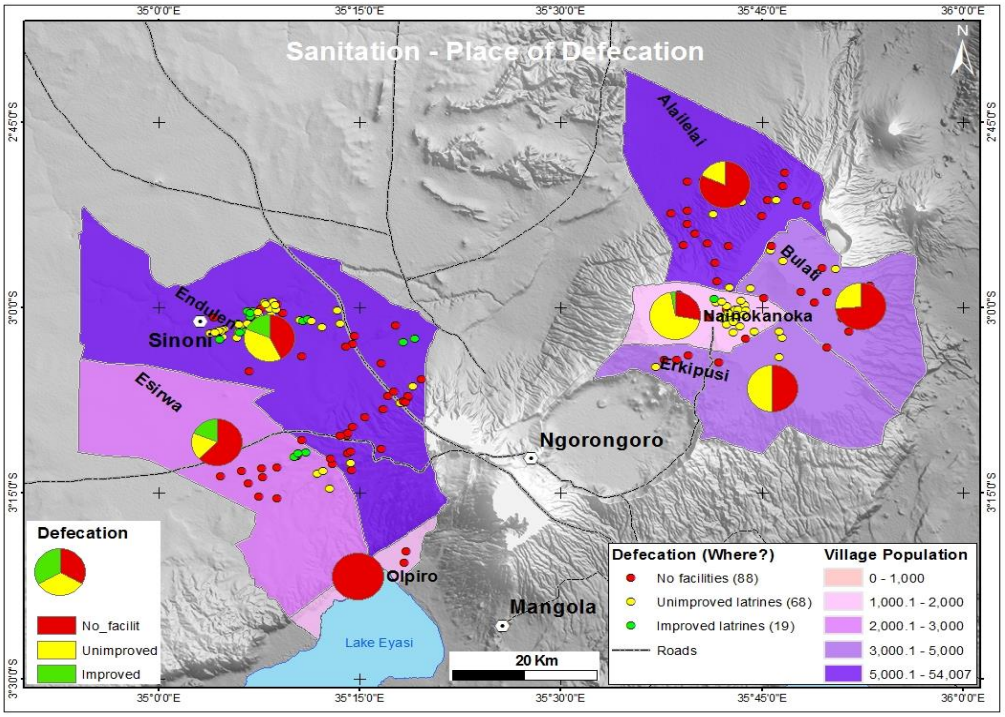

Figure 1: Places for defecation as related to population density

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Sanitation facilities were likely to be present in areas with more social services such as hospital, and non-governmental services (Endulen Ward) unlike in areas where less social services were available (Nainokanoka) (Figure 1). Fewer sanitation facilities were found in areas that were further away from the centre.

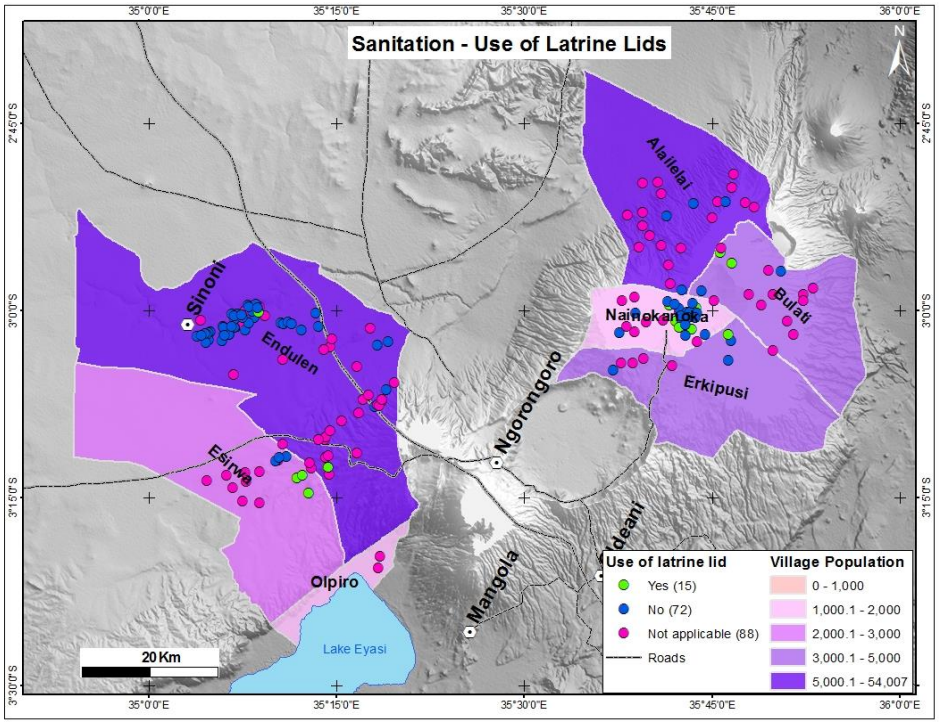

Figure 2: Use of latrine lids

Among those with a sanitation facility (n=86), no faecal matter was found outside the facility and all facilities had a clean floor. Only 17.2% (n=15) of those having a sanitation facility used latrine lids (Figure 2).

Access to water and sanitation facilities

The main source of water reported was an improved water source 61.7% (n=108) in the dry season and 58.3% (n=102) in the wet season. The most commonly reported type of improved water source was protected spring water 27.4% (n=48) and 28% (n=49) in wet and dry season respectively, followed by tap water 26.3% (n=46) and 32% (n=56) in wet and dry season respectively. Stream was the most common unimproved water source, with 35% (n=62) in wet season and 36.6% (n=64) in dry season reported.

Table 1: Socio-demographic factors, history of diarrhoeal diseases and their association with having a sanitation facility (N=175 households)

Characteristics		Total	Has sanitation facility n (%)	Crude OR 95% CI	P-value
Wards	Endulen	88 (50.3)	48 (54.6)	1	
	Nainokanoka	87 (49.7)	39 (44.8)	1.68 [0.37 – 1.23]	0.199
Head of family	Male	76 (43.4)	23 (30.26)	1	
	Female	99 (56.6)	45 (45.45)	1.92[1.02 -3.60]	0.0421
Socio-economic status	Low	62 (35.4)	7 (11.29)	1	
	Moderate	89 (50.9)	51 (57.30)	10.56 [4.32 – 25.72]	< 0.0001
	High	24 (13.7)	10 (41.67)	5.61 [1.81 – 17.38]	0.003
Total family size	1-4	53 (30.3)	13 (24.53)	1	

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	5-10	73 (41.7)	16 (21.92)	0.86 [0.37 – 1.99]	0.731
	>11	49 (28.0)	39 (79.59)	12 [4.71 – 30.57]	<0.0001
No. <5 year children	No	41 (23.4)	28 (68.29)	1	
	1-4	102 (58.3)	34 (33.33)	0.23 [0.10 – 0.50]	<0.0001
	>4	32 (18.3)	6 (18.75)	0.11 [0.04 – 0.32]	<0.0001
Adult had diarrhoea	Yes	39 (22.3)	7 (17.95)	1	
	No	136 (77.7)	61 (44.85)	3.71 [1.53- 9.01]	0.004
Child had diarrhoea	Yes	40 (22.9)	12 (30.00)	1	
	No	135 (77.1)	56 (41.48)	1.65 [0.78 – 3.53]	0.193
Received education on sanitation	Yes	9 (7.8)	8 (88.89)	1	
	No	106 (92.2)	60 (36.14)	0.07 [0.01 – 0.58]	0.014
Motivated for improvement of defecation place	Yes	119 (68)	57 (47.9)	1	
	No	56 (32)	11 (19.6)	0.27 [0.13 – 0.56]	0.001

Determinants for access to a sanitation facility

A household had higher odds of having a sanitation facility if: the head of the family was a female (crude odds ratio(cOR)=1.9, P-value =0.04), had moderate (cOR = 10.6, P-value <0.0001) or high (cOR= 5.6, P-value =0.003) socio-economic status, had a total family size of more than 11 members (cOR=12, P-value < 0.0001), or had no adult that had a history of diarrhoea in the past 6 months (cOR= 3.7, P-value =0.004) (Table 1). A household had a lower odds of having a sanitation facility if it was; in Nainokanoka (cOR=0.7, P value = 0.199), had a total family size of 5 – 10 members (cOR=0.9, P-value = 0.86), had 1- 4 children (cOR=0.2, P-value <0.0001) or more than 4 children under the age of five years (cOR = 0.1, P-value <0.0001), had not received education on sanitation (cOR=0.1, P value = 0.014) and had no motivation for improvement in defecation place (cOR= 0.3, P value =0.001) (Table 1).

Table 2: Logistic regression of determinants of having sanitation facility at a household

Characteristics		aOR 95% CI	P-value
Head of family	Male	1	
	Female	2.56 [0.97 – 6.69]	0.055
Socio-economic status	Low	1	
	Moderate	7.2 [2.06 – 25.08]	0.002
	High	1.95 [0.35 – 10.69]	0.444
Family size	1-4	1	
	5-10	2.64 [0.81 – 8.61]	0.108
	>11	21.69 [6.19 – 76.05]	<0.001
No. of <5 children	No	1	
	1-4	0.25 [0.09 – 0.73]	0.011
	>4	0.10 [0.02 – 0.47]	0.003
Adult with diarrhoea	Yes	1	
	No	3.14 [0.91 – 10.85]	0.07
Received education on sanitation	Yes	1	
	No	0.06 [0.006 – 0.67]	0.022
Motivated for improvement in defecation place	Yes	1	
	No	0.30 [0.1 – 0.87]	0.027

aOR 95% CI: adjusted for head of the family, socio-economic status, total family size, number of under 5 years of age, an adult had diarrhoea, received education on sanitation and aspire for improvement in defecation.

Adjusting for other WASH related factors, those that remained independently associated with having access to a sanitation facility were moderate socio-economic status (adjusted odds ratio (aOR) =7.2, P value = 0.002), family size of more than 11 members (aOR=21.7, P value<0.001) and no adults in the household with history of diarrhoea in the past 6 months (aOR=3.1, P value =

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0.04) (Table 2). Factors that were associated with having lower access to a sanitation facility were having 1-4 (aOR=0.3, P-value=0.003) or more than 4 under five years of age children in a household, not having received education on sanitation (aOR=0.1, P-value= 0.022) and no reported motivation for improvement in defecation place (aOR=0.3, P-value=0.027) (Table 2).

Discussion

While the current study builds on previous studies in Tanzania (Gine-Garriga *et al*., 2015; Dreibelbis *et al*., 2013; Mukoonyo *et al*., 2007) it is among the first studies to contribute to the evidence base regarding the water, sanitation, and hygiene status of one of the most vulnerable and hard to reach pastoral communities in Tanzania. It is a positive finding from the study that more than half of the participants reported that they had access to an improved water source throughout the year. The study results do, however indicate a low availability of sanitation facilities in the two wards in the Ngorongoro Conservation Area. Inter-ward variability was observed, and open defecation was still reported to be a common practice. Access to a sanitation facility was influenced by family size and socio-economic status as well as a history of diarrhoeal diseases among members in a household.

Participants reporting having the same source of water in the wet and dry season may imply seasonal changes do not make an impact in water accessibility in NCA. Other studies carried out in NCA have reported water scarcity in the area (Henderson *et al*., 2015; Bastien *et al.,* 2015), indicating that further studies on this issue may be necessary to better understand to what extent this is an issue. Very few reported that they use rain water harvesting and while the study populations were selected among those with (semi-) permanent settlement, they still could not store and use rain water. This could be related to low SES as there is cost implication in installing a water harvesting system and need for larger storage containers for water. Fetching water for household needs in the study area is a time and labour intensive task primarily taken on by women (Henderson *et al*., 2015). While hand washing may reduce the risk of diarrhoeal diseases (Curtis & Cairncross, 2003), in the context of water scarcity, water for hand washing after defecation may not be prioritized. Studies in NCA found that in addition to soap where available, the community continues to use local plants believed to have antibacterial properties for hand washing and anal cleansing (Henderson *et al*., 2015; Bastien *et al*., 2015)

The rate of open defecation (OD) in the NCA is far higher in comparison to those reported elsewhere in rural areas of Tanzania (McLaffarty, 2003). This finding is consistent with another study carried out in Tanzania that found higher OD rates among livestock keepers (Stephen & Graham, 2014). The rate of improved sanitation is also much lower than the national average estimates of 24% for rural areas and 45% for urban settlements for Tanzania (Thomas *et al*., 2013). The current sanitation status of pastoralists in this study suggests an improvement as compared to 25 years ago, when almost no households among Maasai pastoralists had a pit latrine (Nangawe, 1990).

At the community level, crude analyses indicated there was inter-ward variability with respect to access to sanitation facilities although not statistically significant. From the maps, one can conclude that, population is not a key and/or determinant factor for sanitation facilities accessibility. The majority of the participants in this study reported that they were motivated to improve their sanitation status, however, most of these households already had a facility. In this study, motivation to improve one's sanitation status remained significantly associated with accessing a facility after controlling for other factors, and other studies have found that this is an important determinant (Kema *et al*., 2012). Low reported motivation in this community may be influenced by a range of factors including a perception that unsafe/dirty sanitation facility may by themselves be more detrimental to one's health status than not having a latrine or defecating in the open (Henderson *et al*., 2015). Effective interventions and health promotion initiatives that are culturally and contextually relevant are needed to improve the situation.

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At the household level, affordability was also a key determinant associated with having a latrine. This was shown by those with a higher socio-economic status having greater odds of having a latrine compared to households with lower socio-economic status. This finding is consistent with other studies (Kema *et al.*, 2012). The fact that materials for constructing a latrine were mostly not locally available and had to be bought from Karatu which is outside the NCAA, which requires permission, may also have been a barrier, and highlights the needs to improve structural level determinants such as improvement of access to resources (Jenkins 2004; Galan *et al*., 2013). Household size was found to be a key factor associated with having a sanitation facility, whereby households with more members had higher odds of owning a sanitation facility than smaller sized households and this finding differs from other studies (Bartram *et al*., 2014).

Of interest to note is that families with fewer children under five years of age had increased odds of having a sanitation facility in the household than those that had a greater number of children under-five's in the household. This study did not evaluate where the children's faeces were disposed of, however, these findings are suggestive of factors other than care for the children's health as indicative for using a latrine. For instance factors such as privacy may have been a key determinant (Kema et al., 2012; Stephen and Graham, 2014).

At the individual level, having a female head of the household resulted in higher odds of having a sanitation facility, however after controlling for other factors, this was not found to be statistically significant. Other studies conducted in Tanzania have shown inconsistent findings of the relationship between a head being female and a household owning a sanitation facility. A study in a rural area in the southern part of Tanzania found households with a female head were less likely to own a sanitation facility (Kema *et al*., 2012), while another cross-sectional study in five rural districts found that having a female head increases the chances of a household to own a sanitation facility (Stephen & Graham, 2014).

There are several limitations of this study that must be acknowledged when interpreting the findings. While causal relationships may not be established based on the cross-sectional nature of the study design used, it is of interest to note that few families that had an adult that had a history of diarrhoea in 6 months before the survey had a sanitation facility, and this was found to be an independent determinant for having a sanitation facility. While not all diarrhoea may be linked with poor WASH, a higher proportion would (Pruss-Ustun *et al.*, 2014). A few participants reported that they had received education on sanitation and hygiene practices, however, the study showed that it is also a key determinant.

Based on its design and the way data was collected, the study is prone to selection and social desirability biases. While convenient sampling may have introduced the selection bias, it had to be used to be able to obtain a Maasai group within a permanent settlement who otherwise by being pastoralists would be moving from one area to another.

Despite these limitations, the study still provides a wealth of information on the sanitation and hygiene status of pastoral communities in rural Tanzania. Further qualitative studies are needed to further understand the context, including the drivers behind sanitation and hygiene practices and norms, barriers, and potential strategies to overcome the barriers to improving sanitation and hygiene among pastoralist populations. This information can contribute to the development of culturally relevant interventions and studies than can inform the future development of policy at the district and national levels.

This study contributes to filling the knowledge gap regarding the water, sanitation, and hygiene status among pastoralists in rural and remote Tanzania. Among pastoralists living in the NCA, the use of improved water sources was common, however, their access to improved sanitation facility were lower than the national average for rural areas. Individual and community factors were identified as the main determinants in these communities for owning a sanitation facility. Interventions to improve the water, sanitation, and hygiene status among marginalized and vulnerable populations in rural and remote setting may consider targeting individual and community factors to be effective.

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Authors' contributions

ECN contributed to the study design, supervised the data collection, the GIS mapping, analysed the data, interpreted the results, and writing the first draft of the manuscript. OJ contributed in data analysis, interpretation of the findings and took a lead in finalizing the manuscript. SB and LAB contributed to the study design, supervised the data collection, interpreted the results, and assisted in writing the manuscript. JH, FVM, KO contributed to the study design, the interpretation of the findings, and review of the manuscript. All authors read and approved the final draft of the manuscript.

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